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CONFERENCE PAPER

Integrating sustainability into project management practices: the perspective of professional institutions

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Abstract

This paper is based on a work-in-progress research project; therefore, results and conclusions are preliminary.

Synopsis

Sustainability, in its broadest meaning, has acquired a great importance in modern society and consequently influences almost every aspect of social life. This paper analyses the transformation that the project management profession is undergoing towards the integration of sustainability into its core values and practices.

Research design

This research uses qualitative data from a mix of semi-structured interviews and archival evidence – professional bodies of knowledge, codes of ethics, newsletters, websites, social media platforms, blogs, online databases and international standards – with the intention of

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answering the following research question: what is the influence of professional associations with regard to the institutionalizing of sustainability practices into project management (PM) tools and techniques?

Main findings

Different players influence, in different ways, the PM profession. Our analysis reveals that the nature of these actors is very heterogeneous, and the influence of the professional world of PM on the institutionalization of sustainable project management (SPM) is manifested in the different actions carried on by the entities we highlighted above. Therefore, the shift towards SPM is the result of the combination of each actor's individual strategy (Muzio, Brock & Suddaby 2013).

Research Implications

The analysis of sustainable project management (SPM) is aimed at contributing to the PM academic literature, describing the transformation of PM practices, and to the practitioner literature, engaging with PM professional associations on the way they introduce the set of new practices.

Keywords

Sustainability, Project Management, Professional Associations

Introduction

In the news, undoubtedly a growing attention is being paid to anything connected with sustainability initiatives.[1] Moreover, a strong connection with project management (PM) is also evident from a review of academic publications (Brones, Carvalho & Zancul 2014; Chofreh et al. 2015; Fernández-Sánchez & Rodríguez-López 2010; Marcelino-Sádaba, Gonzalez-Jaen & Perez-Ezcurdia 2015; Martens & Carvalho 2015, 2016; Sabini 2013, 2016; Sabini & Muzio 2017; Sánchez 2015; Silvius & Schipper 2014) or by looking at the publications and announcements of the PM professional associations (IPMA 2015a; PMI 2011, 2016). In addition, there is also a set of new, and non-traditionally established, associations, such as Green Project Management (GPM 2016), and international entities, such as the United Nations Office for Project Services (UNOPS), which are also contributing to the development of new sets of tools and techniques to make projects more sustainable.

Given the importance of projects in modern society,[2] it is to be anticipated that the PM profession will experience a growing pressure from society to balance social, environmental and economic interests in projects. This is happening even more powerfully since the link between

1 See the websites of major newspapers, which permanently host a section with these themes on their homepage, e.g. BBC news has a "Science & Environment" section (http://www.bbc.co.uk/news/science_and_environment); *The Telegraph* has a "Science" section (http://www.telegraph.co.uk/science); The Guardian has a "Sustainability case studies" section (https://www.theguardian.com/sustainable-business/ng-interactive/2015/may/13/guardian-sustainable-business-awards-sustainability-case-studies-database); and *The Economist* has a "Science and technology" section (http://www.economist.com/sections/science-technology).

2 "One-third of the worldwide gross domestic product (GDP) in society is initiated by projects" (Turner, Huemann & Bredillet 2010) cited in (Eskerod & Huemann 2013, p. 44).

sustainability and PM (henceforth SPM) has grown in importance (Silvius & Schipper 2014). Something similar can be observed to have happened to the engineering profession, which has "begun to recognise its larger role in the environmental field and environmental policies" (Boyle 1999, p. 85). For engineers, it was a slow process of incorporating "environmental ethics" (Saad 1997) within all aspects of professional engineering as an essential component of the professional accreditation process.

Comparably, induced by a set of different actors (and primarily the professional associations), a pressure on PM is arising to recognize sustainability as part of PM professional DNA. This acknowledgement is leading slowly to a process of redefinition of PM professional traits (such as considering longer-term effects of projects), in a similar manner to that experienced in the engineering profession. This raises the importance of professional institutions and their position in injecting and disseminating new practices that are sustainability related. Indeed, regulatory agencies, such as professional associations, are "critically important in the theorization process because they enable the formation and reproduction of shared meanings and understandings" (Greenwood, Suddaby & Hinings 2002, p. 61). This means that professional associations can "legitimate change" either by fostering the discourse on sustainability themes (holding conferences and events, issuing newsletters, etc.), or by "reframing professional identities as they are presented to others outside the profession" (Greenwood et al. 2002, p. 59), such as awarding sustainability-oriented professional qualifications.

In this research, we argue that to integrate sustainability in PM, inputs from a broad ecology of actors (in which PM professional associations have a pivotal role) are needed. Therefore, we describe strategies and actions that the PM professional world is carrying out to integrate sustainability into PM. In particular, having collected a large amount of evidence (factual data through archival analysis, backed up by key players' opinions, through semi-structured interviews), we describe the governing mechanisms different actors use to impact the PM profession.

Professional associations and other institutional agents

In this study, we apply Scott's (1995, 2008) theoretical framework to explain institutional pressure on organizations. He identifies analytically the three "pillars" which constitute a framework to determine institutional pressure on organizations. This framework stresses that, "although institutional elements – rules, norms, beliefs – are primarily symbolic in nature, to be of interest these symbols must impact social behaviour: they must be reflected in activities, relations, and resources" (Scott 2008, p. 222). Consequently, every institution is an expression of diverse elements (in Scott's terminology: "pillars") "that depend on different bases of compliance, employ varying mechanisms, evoke differing logics of action, are signaled by different indicators, and offer multiple bases for determining legitimacy" (Scott 1995, chap. 3).

These 'pillars' are grouped into three sets: the *regulative*, the *normative*, and the *cultural-cognitive*. The regulatory pillar originates in coercive power from State laws and rules. The normative pillar relies on those 'social' or 'moral' obligations which are not strictly enforced by a law. Those obligations advocate a given set of behaviours, which are morally sanctioned if not reproduced in a 'legitimate' way. The cultural-cognitive pillar emphasizes those taken for granted or 'orthodox' conceptions which individuals assign to reality to make sense of it.

Therefore, drawing a parallel with the study of Scott et al. (2000), where pressure coming from a different set of institutional actors changed the traditionally established professional governance in healthcare in the San Francisco Bay area, we describe how different PM professional actors are influencing the shift of the PM profession towards sustainability.

In our analysis, we categorized actors' actions according to cultural-cognitive and normative pillars only, as regulatory elements tend to be non-existent. As highlighted briefly before, the regulatory pillar originates in coercive power from state sanctions, and PM is not subject to such sources of influence at present. This is because PM is a non-mandatory profession, and therefore it is not subject to or backed up by state laws and regulations. On the other hand, the normative pillar relies on "social" or "moral" obligations that are not strictly enforced by law but have to be complied with if a project manager is to be considered part of the profession. In our sample, actions displaying this element include professional codes of ethics which embrace SPM, the formal endorsement of international standards on sustainability and the creation of bespoke standards and certifications on SPM. Lastly, the cultural-cognitive pillar emphasizes those taken for granted or "orthodox" conceptions reflective of a recurring professional issue or theme. This suggests the use of "common schemas, frames, and other shared symbolic representations that guide behaviour" (Scott 2008, p. 222). Therefore, actors display these elements when they are involved in advertising SPM or organizing conferences and meetings with a focus on SPM or build training programs for SPM. These actions are oriented towards building a shared idea of what SPM is and how it could and should be integrated into PM practices.

In this way, we broaden the meaning of what Greenwood et al. (2002) label as "regulatory agencies." As such, professional associations (established and new ones), consultants, communities of practice, universities, public entities and individuals constitute the kind of "regulatory agents" that can "legitimate change by hosting a process of discourse through which change is debated and endorsed" (Greenwood et al. 2002, p. 59). The way they make sense of sustainability and PM and the pressure they exert on PM, as stakeholders with different (and sometimes conflicting) interests, determine the developmental trajectory PM will undertake.

In the following sections of the paper, we describe how institutions apply strategies and mediate interactions among the different actors involved (Muzio & Faulconbridge 2013; Sabini 2014), with the aim of defining the development of the topic of "sustainability" among PM practices.

Methodology/data collection

This research was conducted in two separate temporal stages, mixing two kinds of data sources: semi-structured interviews and archival data.

In the first stage, we have conducted 14 semi-structured interviews, in the time span from May 2015 to September 2016. Respondents occupied key positions within a number of both new and established professional PM associations (see Table 1).

Table 1 Interviews held with different PM associations key people

Name of Professional Association	Number of Interviews
Association of Project Management	4
Project Management Institute	4
International Project Management Association	1
Green Project Management	1
EarthPM	1
PMI Community of Practice	3

The interviews followed a standard protocol, lasted between 30 and 90 minutes, and were recorded, transcribed, anonymized and entered into NVivo11 for the subsequent analysis. The general interview outline (Appendix 1) presents questions that were designed to highlight the interviewees' point of view on sustainability, the strategic decisions that they had recently faced in the PM profession relating to SPM, relationships with other actors and issues and obstacles that they experienced regarding SPM.

In the second stage, we performed an archival analysis (from September to December 2016) verifying through factual data the elements which emerged from the semi-structured interviews. We examined documents from professional associations' websites, blogs, newsletters, social media and so on to make sense of the growing importance of SPM within PM discourses. This resulted in the identification of 78 activities performed by professional and non-professional agents; these records have been ordered into a spreadsheet database, and each record is then referenced with respect to its line number (e.g. something which referred to an APM action is labelled as "line 4 – APM").

DATA ANALYSIS

Following others researches (Muzio & Faulconbridge 2013), we coded the data according to Scott's (1995) institutional framework.

Table 2 Actions towards SPM undertaken by different entities grouped by their normative and cognitive element

Type of Action	Action	Actor/Entity
Normative	Code of Ethics	Professional associations
	Endorsing international standards	Professional associations
	Issuing SPM focused or SPM related standards	Social movements, international bodies
	Issuing SPM certifications	Social movements, consultants
Cognitive	Advertising SPM	Professional associations, social movements, consultants, communities of practice, public entities, individuals
	Conferences focusing on SPM	Professional associations, social movements, communities of practice
	Meetings on SPM	Professional associations, consultants
	Trainings on SPM	Universities, consultants, social movements
	Other SPM related events	Communities of practice

This framework allows us to categorize actions according to their displayed cognitive, normative, and regulative element (Scott 1995). In this way, recognizing if an action is legally forced (regulative), is a social obligation (normative) or is a taken-for-granted way of doing things (cognitive), we can group actors' actions into different categories. These actions are illustrated in table 1, where the action and the actors performing it have been associated with

the type of institutional action (normative or cognitive). As is evident from the table, and as we highlighted in the second section, the regulatory element is missing.

The archival data have been organized in a database according to the actor performing the action ("PM professional associations", "non-established professional associations", "Individuals", "Communities of practices", "Consultants", "Public entities", "International bodies" and "Universities"), a brief description, a date, an illustrative quote from data and a web link. Where possible, we also coded archival data with codes derived from the interviews in order to support practitioners' opinions with factual data.

The result of this two-stage data collection and analysis resulted in the production of an empirical narrative to reveal actors involved in influencing the shift towards SPM and their weight behind this shift. Although the interviews were coded according to a grounded style approach, we decided to discuss findings following Scott's (2008) institutional framework, which allows us to place actors and actions according to their normative and cultural-cognitive elements.

Summarizing, the analysis revealed the importance of professional associations (established and new ones) in the shift of PM towards SPM; this happens despite external pressures coming from the society. Therefore, the following sections highlight forces pushing change (PM associations and other actors) and their respective actions.

Forces pushing change

Different players influence, in different ways, the PM profession. Our analysis reveals that the nature of these actors is very heterogeneous, ranging from individuals (acting as a "guru") to associations at different levels (national chapters and corporate levels) and also to public bodies (government agencies such as the Cabinet Office in the UK) and international bodies (such as ISO committees). Therefore, we identified the actors in play in a deductive from archival data, looking at actors' actions and ways in which these actors push the change towards SPM.

However, to introduce each of the actors, we decided to divide them into two sets: PM professionals and "other actors." The first set includes people which work as PM professionals. The second set includes all those actors that are not in the PM world, but have some sort of relationship with it (individuals, consultants, public entities, international bodies and universities).

PM PROFESSIONALS

This section describes the SPM in relation to the influence exerted by the associations' world, which is composed mainly by traditionally established and new PM associations.

When introducing corporate-level PM professional associations, national chapters and non-established associations, an important contrast has to be underlined. Indeed, the landscape of PM associations with regard to SPM is characterized by the contraposition between established (PMI and IPMA) and more recent (GPM, EarthPM) associations. The second group is characterized by several associations, ranging considerably in size, which have been created with the express focus to tackle sustainability (see EarthPM and GPM mission statements later in this section).

Therefore, in the first sub-section are grouped the established PM professional associations (PMI and IPMA), their national chapters (the APM, IPMA Netherland, PMI – California, PMI France, PMI-USA), their communities of practice (PMI – Project Management Global

Sustainability); and in the second sub-section, recently established professional associations (EarthPM and GPM) have been described.

Looking first at traditional associations, the two largest traditional PM associations with the most widespread membership are PMI (Project Management Institute) and IPMA (International Project Management Association) with their numerous national chapters and, according to collected evidences from the archival analysis, their main activities are related to "advertising" SPM. This action is aimed purely at reporting news and signalling advancement on SPM practices. Indeed, to make the point, articles (Gareis, Huemann & Martinuzzi 2009; Gareis et al. 2011) a book (Gareis, Huemann & Martinuzzi 2013; p. X; line 46, PMI), a white paper (PMI 2011), a website definition (PMI 2016) and an annual report (PMI 2013) have been recognized. Basically, in this way there is a recognition that the topic is of rising importance, but without any direct action to amend PM practices. This recognition occurs also at a national level with the APM in the UK, which acknowledges publicly on its website how projects need to consider sustainability (line 4 – APM) and promotes several case studies that highlight SPM (line 7, 8, 9 – APM). Similarly, the IPMA Netherlands has adopted a motto inspired by SPM: "Better projects for a better world" (line 36 – IPMA Netherlands).

PMI and IPMA are not just involved in advertising mechanisms, but also demonstrate a desire to have a direct influence on SPM by organizing conferences and endorsing standards.

Interestingly, on the "conference" side, IPMA organized the "IPMA Research Conference" on PM and sustainability with an explicit focus to "shed light on the obstacles [to sustainability]". Furthermore, looking at IPMA's new "Individual" (IPMA 2015c),[3] "Project" (IPMA 2016b)[4] and "Organizational" (IPMA 2016a)[5] competence baselines, it is possible to note how they all refer in some way to SPM.

PMI has also (through one of its chapters) endorsed the UN Global Compact, which is considered "the world's largest corporate sustainability initiative" (www.unglobalcompact.org). The chapter declared that it "supports the ten principles of the Global Compact with respect to human rights, labor, environment and anti-corruption" (line 59 – PMI France). Moreover, other PMI national chapters host meetings on the topic of sustainability in general or on SPM in particular. One notable example is the PMI – California with "I'm a Project Manager – Is Sustainability My Problem?" in 2016 (line 53 – PMI California 2016).

Perhaps the most important sign of professional associations' engagement in SPM is the creation of communities of practice (CoP) and special interest groups (SIG). CoPs and SIGs represent a number of individuals who are engaged in sustainability and advertise SPM (line 49 – PMI CoP 2008) or organize events (line 37 – PMI CoP 2011). Individuals in these groups express their vision on SPM though articles in PM association blogs (line 32, 33, 34 – IPMA blog 2016),[6] social media (line 78 – list of LinkedIn groups 2016) and books (Taylor

3 "Identify, and ensure that the portfolio complies with relevant sustainability principles and objectives" (IPMA 2015c, p. 298).

4 "We now expect every excellent project to consider sustainability and the environment with a long-term perspective, not as an option but rather as the default" (IPMA 2016b, p. 47)

5 "Describes the concept of organizational competence and how this should be used to deliver organization's vision, mission and strategic objectives in a sustainable manner" (IPMA 2016a, p. Executive Summary).

6 "They all need to be managed in a coordinated way from a long-term perspective"; "This is why sustainability and resilience will be key concepts to be considered for the way we manage our projects"; "It also deals with the responsibility of project managers towards the wider society, including sustainability and the environment" (IPMA blog 2016 – lines 32, 33, 34).

2011, l. line 10). These tools create the possibility for project managers to exert an influence on SPM outside of the strict control of the corporate level of the professional associations.

The second category, in contrast the first, is comprised of new and/or informal associations. Under this label, we group new associations (i.e. GPM – Green Project Management), social movements (i.e. EarthPM) and online groups[7] which have been established with the explicit intent of tackling SPM or sustainability in general.

Non-established professional associations such as GPM and EarthPM (both founded in 2009), as with more established ones, promote SPM in many ways. This seems to be quite normal, since their mission is "at the intersection of Sustainability and Project Management" and they have been established "to advance sustainability in Project Management" (GPM website 2016).

Nonetheless, pushing forwards respect to traditional and established PM associations, new ones advance SPM by developing bespoke SPM standards, methodologies, certifications and courses. GPM issued the "GPM® P5™ Standard for Sustainability in Project Management" (line 77 – GPM), which provides a measurable framework for projects useful for sustainability reporting. This bespoke standard "is a tool that supports the alignment of Portfolios, Programs, and Projects with organizational strategy for Sustainability" (GPM 2016, p. 13). Additionally, GPM issued in 2013 a process-based, structured methodology for managing change, the "PRiSM." This methodology helps organizations to change towards P5 standard as it underlines areas of "sustainability and integrates them into the traditional core project phases to reduce negative environmental and social impacts in all project types using the GPM P5 Standard" (Carboni, González & Hodgkinson 2013, l., line 73).

Moreover, training courses have been set by EarthPM and GPM to improve project managers' abilities in SPM ("Distinguish yourself! Get certified in Green Project Management" – line 18 – EarthPM 2012 and "GPM® Certification, PRiSM methodology" – line 19, 74 – GPM 2012). And also, very often, these courses end up with SPM certifications ("Earning the GPM™ Certification puts you in a special league, positioning you as a change agent with the know-how to apply sustainable methods to projects" – line 75 – GPM).

Another method non-established associations use to spread SPM tools that they have developed is through collaboration with universities. They build masters' programmes partnerships to "provide institutes of higher learning with a turnkey sustainable project management program that can be utilized for undergraduate, masters, or continuing education" (line 22, 23 – GPM).

The underlying idea for non-established associations is the marketization of tools they develop. Indeed, to sustain themselves, these associations need to supply their products to a wide set of individual, organizational and institutional actors ("we can help you cultivate value from sustainability" line 20 – GPM 2012).

OTHER ACTORS

In addition to actors strictly involved in PM, a multitude of different actors make an impact on the profession. Among actors which exert an influence towards SPM are listed consultants (e.g. APMG International, LIFE Academy, MIT/Sloan & BCGroup report, SustainAbilities,

7 I.e. Green Project Managers, Boston Area Sustainability Group (BASG), GreenBiz.com, Project Management and Global Sustainability, Sustainability Career Group, IISPM, Sustainable Business Management, Sustainability Professionals.

Sustainability Learning Centre, Sustainable Measures, The Economist, Isos Group), public entities (i.e. AXELOS, Cabinet Office, Office of Government Commerce, Salix Finance), international bodies (e.g. United Nations and ISO) and universities (e.g. Aberdeen University, Lille University, Malmo University).

Similar to PM professional associations, this set of actors pushes ahead its interests towards SPM with different strategies. Above all there is what we called before "advertising SPM," which is fulfilled mainly by consultants (through blogs and online articles, database line 64 – Sustainable Measures database line 69 – ISOS Group, 2016) and public entities (providing examples of best practices in public projects database line 14 – CabinetOffice, 2012).

Moreover, among the several strategies this set of actors put in place are also activities which indirectly affect SPM, such as sustainability conferences ("The Sustainability Summit 2017" line 68 – The Economist, 2017), certifications ("Project Management for Sustainable Development – PM4SD™ – is a specialised certification scheme for Project Managers working in the tourism sector" line 12 – APMG International), training (Master in "Project Management and Sustainability, line 67 – Malmo University), courses (see the online course "Green/Sustainability Project Management" (line 63 – SustainabilityLearningCenter, 2014) and standards (see ISO 21500 "Guidance on PM": "The benefit is to use the resources deployed in the most efficient way, or reaching more with less resources", line 39 – ISO 2012).

Strategies adopted

The influence of the professional world of PM on the institutionalization of SPM is manifested in the different actions carried on by the entities we highlighted above. Therefore, the shift towards SPM is the result of the combination of each actor's individual strategy (Muzio, Brock & Suddaby 2013).

As anticipated, to describe the set of actions undertaken by professional actors we decided to use Scott's (1995) institutional framework. Some actors (i.e. professional associations, social movements and consultants) issue both normative (e.g. endorsing sustainability standards, developing codes of ethics which include SPM, etc.) and cognitive (e.g. advertising SPM, organizing conferences, meeting and trainings) actions, whereas others tend to issue actions belonging only to one institutional category (e.g. universities, communities of practice, public entities and individuals perform only actions with cognitive elements).

ACTIONS DISPLAYING CULTURAL-COGNITIVE ELEMENTS

Activities which display cognitive elements are those culturally supported values, beliefs and assumptions coming from a wide range of actors (see Figure 1). For instance, those focused on reporting news and signalling advancement of SPM practices are among the most widely diffused.

The process of advertising SPM ideas is led by a broad set of different actors, but with the common idea that "all kinds of work has to be directed or at least influenced by the concept of sustainability" (interview 6, PMI). PM professional associations, as well as consultants, public entities and individuals issue articles and carry out miscellaneous activities in order to raise awareness on this topic with the common underlying idea that "this is a big gap" (interview 13, EarthPM). Nonetheless, the acknowledgement of this "gap" in PM tools and techniques is seen as an expression of the newness of the topic ("I think that it is normal to have a gap exist when a topic is new and we can say that sustainability is quite a new topic in the project management arena" – interview 11, consultant).

Indeed, PMI supported ways of advertising SPM concepts by sponsoring research which then materializes in articles (Gareis et al. 2009) and books (Gareis et al. 2013). Also IPMA, through its blogs (line 32, 33, 34 – IPMA blog 2016),[8] social media (line 78 – list of LinkedIn groups 2016), and books (Taylor 2011) has similarly contributed to support SPM advance.

This range of activities acknowledges the importance of SPM as a topic but exhibits no intent to analyse the concept further, as in the example of a UK public-owned body (AXELOS) publishing an article complaining about the absence of implementation of SPM.[9] This article is recognizing that "sustainability clearly has a link in many aspects of management and many aspects of work actually in general" (interview 6, PMI); nonetheless, it calls for further implementation in project and portfolio management techniques. Furthermore, a UK public entity (Cabinet Office) mentions sustainability in different parts of a construction strategy document (line 14 – Cabinet Office 2012) as a way to publicize its importance in the projects.

As demonstrated, PM professional associations are not the only actors who analyse SPM concepts, as a number of new PM associations and consultants also provide reports or offer examples on how SPM can be unpacked and examined in its key concept (e.g. consider sustainability issues in the beginning of every project, include all the stakeholders in key project decisions). Here the reasons to analyse SPM will be slightly different from those of the established professional associations. For this kind of actor, the intent is to set a market around some service they provide. One example is the Boston Consulting Group (BCG) Report on "Investing For a Sustainable Future" (Unruh et al. 2016), where it is explicitly underlined that "a growing number of investors are paying attention to ESG[10] performance, as evidence mounts that sustainability-related activities are material to the financial success of a company over time" (line 54 – BCG 2013). In this document BCG provides a report on how corporate leaders should respond to the growing interest in sustainability. Another report worth mentioning is the one from EarthPM which, through examples of SPM practices, explores how some companies adopting SPM improved their overall performances (line 58 – EarthPM 2016).

ACTIONS DISPLAYING NORMATIVE ELEMENTS

Actions which display a normative element are those morally governed and originating as a part of a social obligation and are mainly performed by professional associations, social movements and consultants. PM professional codes of ethics which address sustainability, issuing bespoke SPM standards or endorsing international ones, are all examples of this kind of voluntary activity which is socially and ethically dictated.

Indeed, among the reasons for giving sustainability an impetus in public opinion (and therefore also to SPM), undoubtedly there is an intrinsic ethical concern. Sustainability, in pursuing "ecological health," "social equity," and "economic welfare," raises huge ethical

8 "They all need to be managed in a coordinated way from a long-term perspective"; "This is why sustainability and resilience will be key concepts to be considered for the way we manage our projects"; "It also deals with the responsibility of project managers towards the wider society, including sustainability and the environment" (IPMA blog 2016 – line 32, 33, 34).

9 "Project management forms a part of portfolio management and in both there is currently a lot of talk about the issue of sustainability but not a lot of implementing sustainability in portfolio management" (line 13, AXELOS 2005).

10 (Environmental, social and governance).

challenges which are involved in its promotion and achievement. PM professional associations, social movements and consultants understood these social requirements and therefore issued direct actions to tackle them.

As per a common definition, ethics "seeks to address questions about morality, concepts like good and bad, right and wrong, justice, virtue, etc." (Moore 2012). Therefore, notions such as "good and bad" and "right and wrong" are embedded in ethics definition. These notions emerge very clearly from the discourse on sustainability in general: "organizations that separate the 'doing the right thing' from 'doing things right' tend to be more successful in the long term" (Gartner 2006), meaning that these two concepts are tied together. Consequently, in the world of PM, a strong connection between SPM and ethics it is also shared: "A project run with green intent is the right thing to do, but it will also help the project team do things right" (Maltzman & Shirley 2010, p. 54).

Ethical concerns are implied even more often in practitioners' discourses when considering the importance of SPM and referring to it as "a more general thing that everyone should observe as something that's good for the world" (interview 1, APM). Again, the discourse abounds with ideas of "doing the right thing," and "if project managers have that responsibility or that power in our hands we should make good use of it" (interview 11, consultant). Concerns about ethics arise so strongly in some discourses that the conditions driving the project may lead to some ethical warnings, wherein it is suggested that the project manager has to decline from taking on the project: "It's a matter of principle, so if we think it's unsustainable in what they're doing, then as a matter of principle we might refuse the project to go any further" (interview 2, APM); also: "I try to teach my younger project managers that there are some projects you need to walk away from. And if you are unhappy about the ethics or you're unhappy about the sustainability issues, those are the things you should walk away from" (interview 1, APM).

PMI and IPMA identify SPM as part of their codes of ethics, advertising its main ideas publicly on their websites (line 34 – IPMA 2016, and line 50 – PMI 2016), and therefore recognizing that "there is a significant appetite for bringing sustainable principles into project management" (interview 1, APM). Furthermore, examining the presence of SPM in codes of ethics, it is revealing how strong the link between these two ideas is. Indeed, looking closely at the codes of ethics it is possible to find strong references to SPM.[11] Interestingly, both the IPMA code and the PMI one, recognize the influence that projects have on "sustainability," but without mentioning the word explicitly, as only the three pillars of sustainability (environmental, social and economic) are named.

Among other morally governed actions, there is a notable example of PMI establishing a community of practice on SPM in 2010 (see the "Global Sustainability Community of Practice"). This community was founded with the aim to be recognized as the "global driving force for implementing Sustainability in Organizational PM" (line 37 – PMI). But, as seen before, there have been other ways for PMI to support SPM concepts as sponsoring research materialized in articles (Gareis et al. 2009) and books (Gareis et al. 2013). Furthermore, recently (beginning in 2017) even PMI national chapters have regional meetings making a business case out of SPM: "basic and advanced project management techniques will be

11 IPMA – "We recognize that our projects, programmes and project portfolios, affect people, society and the natural environment in various ways, both locally and globally" (IPMA 2015b).

PMI – "Ethics is about making the best possible decisions concerning people, resources and the environment" (line 56, PMI – Code of Ethics).

compared to sustainable methods used by many companies to remain competitive" (line 60 – PMI New Hampshire). Another established PM professional association, IPMA, with meetings and events (see IPMA Research Conference in 2016 [line 29] and Global Young Crew Workshop 2016 [line 57]), is fostering the discourse over SPM aiming at understanding and clarifying its concepts.

Behind these activities there is the recognition that the topic is growing fast (it "is a critical societal imperative", line 37 – PMI Community of Practice 2011), and there is the need to understand the implications for the PM profession in terms of expectations and responsibilities attached to the profession ("improve how practitioners of all levels manage the complexity and dynamics of organizations, projects and programs" [line 46 – PMI 2013]).

Conclusions

To ultimately integrate sustainability into the PM profession, inputs from a broad ecology of actors are needed. This is the first conclusion that we draw from this analysis. While established PM professional associations (PMI and IPMA) play a pivotal role, influences from other actors (and especially non-established associations such as GPM and EarthPM) are fundamental.

In Figure 1, we describe actors from our sample, their interactions and their influence on the PM profession. In particular, this picture shows how different entities influence the PM profession with respect to SPM and which approaches they have implemented. This relationships map is derived from our evidence, and therefore its main limitation is that it is a preliminary and probably still incomplete picture of this field.

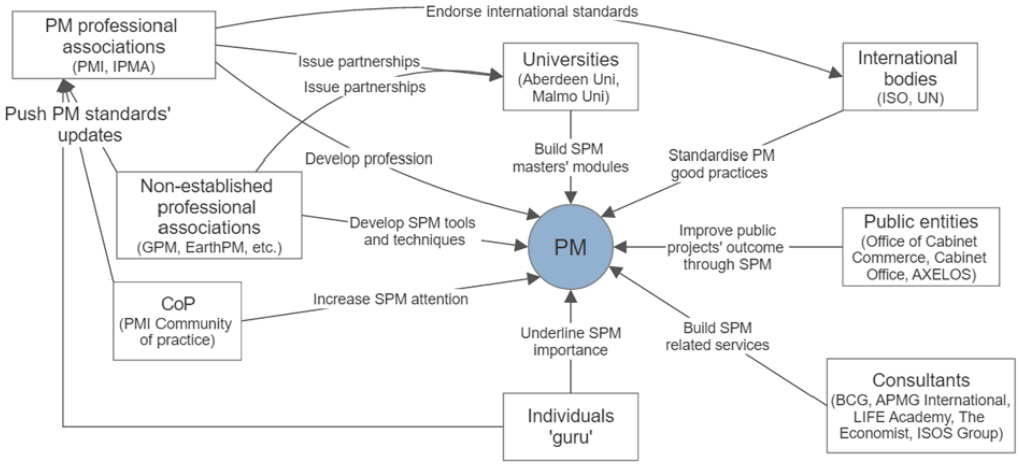

Figure 1 Actors and their relationships as "regulatory agents"

Indeed, some more detailed considerations from this analysis arise from the comparison between actions of established versus non-established associations. The first consideration relates to the overall strategy adopted by these actors; although non-established associations seem to have implemented an "active engagement" on the topic of SPM, the established ones are adopting more of a "wait-and-see" strategy. The second consideration is related to the way the topic of sustainability is dealt with.

ACTIVE ENGAGEMENT VS "WAIT AND SEE"

A fundamental difference between new and established PM professional associations is in the aim of the association. Associations such as GPM or EarthPM have been created as a response to the need of practitioners for guidelines and best practices on how to implement sustainability metrics within everyday practices, whilst established associations have a broad approach to PM, such as its professional advancement and the improvement of project success (see PMI "Core purpose" and IPMA vision).[12]

Although both sets of institutions have some kind of strategy towards sustainability, the strategies they pursue are diametrically opposed. The newest associations usually tend to show an active engagement towards sustainability: creating bespoke standards (GPM 2016), producing monitoring methods (Carboni et al. 2013) and issuing related certifications (line 75 – 'GPM Certifications'). The established associations adopt more of a wait-and-see strategy, contemplating the importance of sustainability and raising their members' awareness of the issue, but with few actions adopted to tackle the issue in a practical way (IPMA 2015c, 2016a, 2016b).

"SPLITTING' SUSTAINABILITY"

Sustainability is a very broad concept, and it is difficult to tackle holistically. The idea itself can hardly be introduced into professional practices simply by introducing the word *sustainability* in the professional bodies of knowledge. Instead it can more easily be injected into professional core practices, slowly and gradually, following a progressive approach. PM professional associations are therefore adopting a low-risk strategy by embracing gradual and adaptive changes to their practices and objectives. As an example, looking at statements in the code of ethics, such as the IPMA code, pillars of sustainability are mentioned, but without using the word itself: "Our projects, programmes and project portfolios, affect people, society and the natural environment in various ways, both locally and globally" (IPMA 2015b).

Although it is necessary to recognize that the last IPMA competence baseline (the ICB4) has a paragraph on sustainability (6.3.3.4 "Identify, and ensure that the portfolio complies with relevant sustainability principles and objectives" – IPMA 2015a: 298), the well-known and most recognized PM body of knowledge, the PMBOK (2013), does not yet dedicate a section (or a paragraph) to it.

This reveals a cautious approach on the part of PM professional associations, which are concerned not to detract their members from other important responsibilities and constraints. Therefore, by introducing the concept of sustainability gradually, they recognize that the topic is important to the profession, but are not willing to turn upside down the set of techniques and standards that have been built during the development of the PM profession.

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12 From the PMI strategic plan, the core values are "to advance the practice, science and profession of project management throughout the world in a conscious and proactive manner" (PMI 2012, p. 3); and from the IPMA vision: "Promoting competence throughout society to enable a world in which all projects succeed" (line 70, IPMA).

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Appendix 1 – Interview protocol

1. How did you get involved into professional associations?
2. As [role in the association] have you ever bumped in discussions/decisions/projects over sustainability topic?
3. As a practitioner have you ever bumped in discussions/decisions/projects over sustainability topic?
   - And as a professional association member?
4. According to academic and practitioners' literature there is a growing link between sustainability and PM, do you share this vision?
5. Do you believe that PM as a profession has a critical role on sustainability topic?
   - What is "sustainable project management" in your reflections?
6. Do you recognize any active engagement by professional associations towards sustainability?
7. Provocative answer:
   - buying the idea of the need of integration of sustainability and PM, how much weight do you think could have a project manager in bringing the sustainability into the project? In comparison of clients, contractors, consultant designers…
8. Does a gap exist between literature (importance of sustainability in PM) and reality (what is carried out in practice)?
   - If so, how can be the gap filled?

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CONFERENCE PAPER

Improving the accuracy of project estimates at completion using the Gompertz function

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Synopsis

A nonlinear regression-based growth model based on the Gompertz S-shaped function is used to forecast cost profiles for ongoing projects experiencing overruns. Based on the standard approach to earned value management and earned schedule, a simple linear expression is derived for the forecast of the duration estimate, and the theoretical formula is validated by application to case projects. The model's predictions are shown to be accurate, stable and reliable. We conclude with practical guidance for project managers.

Relevance for practice and education

An effective method of duration and cost forecasting is established and validated. The duration and cost error formulas are quite simple and practically useful to project management practitioners during project monitoring and control.

DECLARATION OF CONFLICTING INTEREST The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. **FUNDING** The author(s) received no financial support for the research, authorship, and/or publication of this article.

Research design

Using the standard definition of the earned schedule and Gompertz curve cost profiles, estimates of the final duration are found by using regression curve fitting on the first and last available earned value data. Validation is conducted on many synthetic project data sets.

Main findings

It is found that a simple two-point curve-fitting estimation formula is effective in predicting the duration of an ongoing project.

Research implications

This research broadens discussions on accuracy on nonlinear duration and cost estimates of ongoing projects, using different cost profiles and the standard definitions of the earned schedule.

Keywords

Duration Estimation, Cost Estimation, Gompertz function, Earned Value Management, Earned Schedule

Introduction

Earned value management (EVM) and earned schedule (ES) are widely recognised methodologies that are used to compute duration and cost estimates at completion for in-progress projects. Traditional EVM and ES methods use index-based formulae that are linear, but why should such models be assumed to be reliable when realistic cumulative cost curves are usually S-shaped (Khamooshi & Golafshani 2014)? As a result, nonlinear regression-based estimates have been developed to overcome some of the limitations of linear methods and to better model the S-curve cost profiles of projects in a variety of industries. Such methods are regarded as more sophisticated and are able to generate improved estimates for nonlinear cost growth patterns (Christensen & Heise 1992).

Several growth models are available to describe the S-shaped cost profile of a project (Narbaev & DeMarco 2014a). In particular, the Gompertz function is an interesting sigmoidal curve that is often used to describe phenomena inherent to data with a Sshaped growth pattern. Thus, project EVM datasets can be modelled using Sshaped Gompertz functions for their cumulative cost profiles. Previous research findings have revealed that the Gompertz function is a valid and useful nonlinear cost profile that helps in computing refined estimates of the actual, future duration and cost (Trahan 2009; Narbaev & DeMarco 2014a,b).

The solution to the nonlinear duration estimation problem was provided by Warburton and Cioffi (2016), who constructed a formal theory based on standard earned value management (EVM) and earned schedule (ES) assumptions, which applies to all projects, even those with nonlinear cost profiles. They showed that the standard duration estimation formula, which was previously believed to apply only to linear profiles, actually applies to several types of nonlinear cost profiles, which significantly extends its range of validity.

However, not all cost profiles result in the same, standard duration estimation formula, and therefore it is of interest to determine whether other profiles that have been used successfully

in the past in the prediction of cost and duration, result in the standard formula. Therefore, here we investigate the use of the Gompertz function to predict duration and cost estimates at completion.

Relevant literature

EVM provides early estimates of the project's final cost, which many studies have found be reliable in practice (Christensen & Heise 1992; Christensen 1993). ES is the basis for duration estimation (Lipke 2003, 2010) and has been shown to work well for many real-world projects (Batselier & Vanhoucke 2015c; Colina & Vanhoucke 2015). However, Evensmo and Karlsen (2006) pointed out that the standard duration and cost estimation formulas are based on linear cumulative cost curves. This was further clarified by Kim and Kim (2014), who showed that both forecast accuracies and early warning credibility are sensitive to S-curve profiles, especially early in a project. Therefore, the nonlinearity of the cost curves significantly affects future estimates.

Batselier and Vanhoucke (2015c) analysed three duration forecasting approaches: the planned value method (Anbari 2003); the earned duration method (EDM); and the earned schedule method (ESM). Lipke (2003, 2010) created the linear duration estimate formula by defining a geometrical construction procedure to determine ES. Khamooshi and Golafshani (2014) criticised ES, along with other EVM analyses, for using monetary measures as a proxy for the true duration and argued that such measures may not accurately represent the duration's progress. They proposed the EDM, which decoupled the cost and schedule dimensions by using actual durations rather than their monetary proxies.

According to Vanhoucke and Vandevoorde (2007), all forecasting methods yield similar results, regardless of the method used, which Jacob and Kane (2004) attributed to the high correlation among the methods and that they apply the same basic parameters. Teicholz (1993) compared three forecasting methods for final cost using data from 121 real projects.

Using the real-life project database constructed by Batselier and Vanhoucke (2015a), the three methods were evaluated by Batselier and Vanhoucke (2015b). Although all three methods were found to be practically useful, EDM performed the best. Lipke et al. (2009) studied 12 projects, and estimates of both the final cost and the duration were claimed to be sufficiently reliable for general application. Typically, forecast accuracy is reported as the mean absolute percentage error (MAPE) between the model's prediction and the actual project data (Chen, Chen & Li 2016; Batselier & Vanhoucke 2015b). However, the time over which the mean is taken varies among authors. Also, as Kim (2007) pointed out, an average measure of the error over the entire project's execution has little practical use, as project managers prefer early estimates.

Several researchers have enhanced the linear EVM model. Evensmo and Karlsen (2006) proposed a cubic polynomial cost curve, and Warburton (2011) developed a time-dependent EVM model for projects that follow the nonlinear Putnam-Norden-Rayleigh (PNR) profile (Putnam 1978). Cioffi (2006a) showed that a model often used in population dynamics can be applied to project S-curves, and gave an interesting example of its application to the development of the Oxford English Dictionary, a project spanning many decades (Cioffi, 2006b). Warburton (2014) used a trapezoidal labour profile, which can describe construction projects, to derive accurate duration estimates early in the project.

Elshaer (2013) suggested that although ES sometimes outperformed other methods, it failed when incorrect warnings emerged from non-critical activities. Vanhoucke (2012)

confirmed that the network topology is a significant driver of variability, that S-shaped curves degrade forecasting accuracy and that networks with greater parallelism have more variability. Warburton and Cioffi (2016) recently developed a formal, theoretical foundation for duration estimation that applies to nonlinear, S-shaped cost profiles, which provides a significant motivation for this research.

Chen et al. (2016) reported the accuracy of forecasts using MAPE, and though their model improved forecasting accuracy, it required a logarithm linear transformation of the planned value data and linear regression. Zwikael, Globerson and Raz (2000) evaluated five forecasting models using the mean square error, the mean absolute deviation and the mean absolute percentage error. Narbaev and DeMarco (2014b) proposed a Gompertz-based growth model, using nonlinear regression curve fitting, that improved forecast accuracy (as measured by MAPE) by including schedule progress as a factor in the cost performance.

Data from decades of completed US Department of Defense contracts established that the cost performance index (CPI) rarely changed by more than 10% once the contract had reached the 20% completion point, regardless of the type or phase of the defence contract, weapon system or military service involved (Christensen & Payne 1991). Therefore, in practice, the CPI seems to be a reliable indicator after the 20% completion point. Kim and Kim (2014) analysed timeliness by examining seven duration forecasting methods and showed that forecast accuracy and early warning credibility are very sensitive to S-curve patterns, especially early in a project.

The Gompertz Curve

The Gompertz function is often used to describe phenomena with inherently S-shaped growth patterns and has found wide application in many industries that feature population growth, such as biology and social sciences. As it is extensively used in curve fitting and forecasting, the Gompertz function can be useful in characterising the S-shaped cost profile of projects in a variety of industries, especially when it comes to estimating project overruns due to cost and duration growth (Trahan 2009; Narbaev & DeMarco 2014b). The Gompertz function has been proven as a statistically valid model able to generate more accurate schedule-integrated cost estimates than other nonlinear models, such as the logistic, Bass and Weibull functions (Narbaev & DeMarco 2014a).

The Gompertz curve is typically written as follows:

$$G(t)=\alpha\exp\left[-e^{\beta-\gamma t}\right], \tag{1}$$

where α, represents the asymptotic value ($t \to \infty$) of the Gompertz function and therefore is related to the final budget of the project. That leaves two parameters to be determined, and in the above representation, neither have an obvious project management interpretation.

Therefore, we eliminate β, by defining, $\beta = \gamma T$, where T is the peak in the distribution function, $g(t) = G'(t)$. Differentiating $G(t)$ with respect to t gives $g(t)$, and differentiating again and setting the result to zero shows that T is the peak in the distribution function. Thus, T is a parameter that directly determines the duration of the project, and, in fact, we will show that it is directly related to the actual end time of the project. That leaves just one parameter, γ, which characterises the growth rate of the cumulative curve, and allows for the study of a wide variety of different project cost profiles. Figure 1 presents Gompertz functions with three different values of γ that are similar to real-world project databases (Narbaev & DeMarco 2014b).

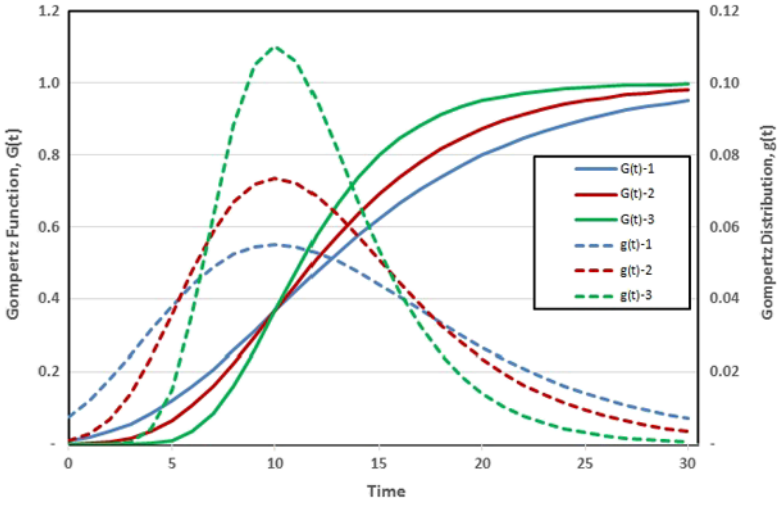

Figure 1 Gompertz functions (solid) and Gompertz distributions (dashed) with the same value of T = 10; asymptote, α = 1l and different values for γ: blue = 0.15, red = 0.20 and green = 0.25

The Gompertz function and the distribution function are then:

$$G(t) = \alpha \exp\left[-e^{-\gamma(t-T)}\right],$$
$$g(t) = \frac{dG(t)}{dt} = \alpha\gamma G(t) e^{-\gamma(t-T)}. \quad (2)$$

The definition of the end of the project requires some care. The Gompertz function never reaches its asymptotic value, but the planned end of the project is defined to be at a specific time, $T1$. We can define the end of the project as some specific fraction of the asymptotic value, such as 95% or 99%, in which case, at the planned end of the project,

$$G(T_1) = (1-\varepsilon)G(t \to \infty) = (1-\varepsilon)\alpha = \alpha \exp\left[-e^{-\gamma(T_1-T)}\right]. \quad (3)$$

where ε is a constant. It is convenient to define k as

$$1-\varepsilon = \exp\left[-e^{-k}\right], \quad (4)$$

which gives,

$$k = \gamma(T_1 - T)). \quad (5)$$

Therefore, k is determined once we chose the specific end point of the project as, say, 99% of the asymptote, α. This relation also shows that there is a direct relation between the peak in the distribution function, T, and the end of the project. Further, this gives a practical project management interpretation to the parameter, T, which determines the duration of the project.

Duration and cost estimate formulas

We follow the standard approach to EVM and use Gompertz functions for the cumulative planned value, $Gp(t)$, earned value, $Ge(t)$, and actual cost, $Ga(t)$:

$$G_p(t) = \alpha_p \exp\left[-e^{-\gamma_p(t-T_p)}\right],$$
$$G_e(t) = \alpha_e \exp\left[-e^{-\gamma_e(t-T_n)}\right], \quad (6)$$
$$G_a(t) = \alpha_a \exp\left[-e^{-\gamma_a(t-T_a)}\right],$$

The *p* subscripts denote planned parameters; the *e* subscripts denote earned parameters; and the *a* subscripts denote actual parameters.

The total planned cost is the budget, $B = Gp(T1)$ and the cost estimate at completion is, $E = G_a(T'1)$. The same budget, *B*, is used as the final cost for both planned and earned values. In this, we follow the standard EVM approach, which says that as each activity is completed, it earns its planned value, even if there is a cost increase or a delay in completing the activity (PMI 2013, 2011). Therefore, at the end of the project, when all the planned work has been completed (i.e. earned), the total earned value equals the total planned value, $Ge(T'1) = Gp(T1)$. If unplanned work is proposed (e.g. a scope increase), the project must be re-planned, which will generate a new planned cost profile and all formulas in this paper then apply with the new profile replacing the old.

In standard EVM, if no scope creep occurs, the standard cost estimate at completion, CEAC, is the ratio of the budget to the cost performance index, that is, *CEAC = Budget/CPI* (PMI 2011).

We define the planned end point of the project as T_1 and assume that, during execution, it ends at T'_1. If the project is delayed, $T'_1 > T_1$, and if the project is accelerated, $T'_1 < T_1$.

According to the standard EVM methodology, when each activity is completed, it earns its planned value, even if there is a delay in the execution or a cost increase. Therefore, at the end of the project the cumulative planned value, $C_p(t)$, is equal to the cumulative earned value, $C_e(t)$,

$$C_e(T'_1) = C_p(T_1). \quad (7)$$

If the planned and earned value curves end at the same percentage of the asymptote (e.g. 99%), then using equation 5, gives

$$\gamma_p(T_1 - T_p) = \gamma_e(T'_1 - T_n), \quad (8)$$

Equation 8 is referred to as the 'end point condition' and is more usefully written as

$$T'_1 = T_n + \frac{\gamma_p}{\gamma_e}(T_1 - T_p). \quad (9)$$

This equation determines $T1$ and T'_1 in terms of the peaks in the planned and earned value distribution functions, *Tp* and *Tn*.

If the project is delayed, at the current time, *t*, the delay, $\delta(t)$, is defined as the time difference represented by the horizontal projection back from the point on the earned value curve, at *t*, to its intersection with the planned value curve (see Figure 2). For accelerated projects, the projection is forward in time. The mathematical representation of this condition is (Warburton & Cioffi 2016)

$$G_e(t) = G_p[t - \delta(t)]. \quad (10)$$

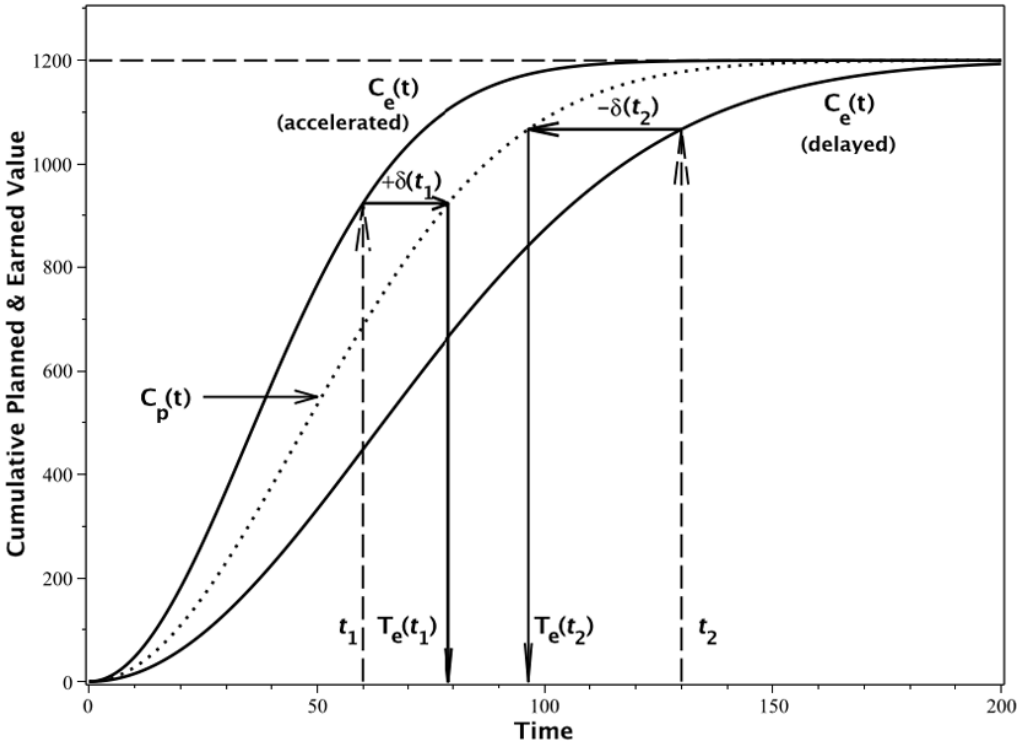

Figure 2 Definition of the delay, $\delta(t)$, as the difference between the earned and planned value curves: $+\delta(t1)$ is an accelerated project, and $-\delta(t2)$ is a delayed project. The corresponding earned durations are denoted as $Te(t1)$ and $Te(t2)$.

We now introduce a new quantity: the earned duration, $Te(t)$, which is defined as a time-difference: the current time minus the delay, $\delta(t)$:

$$T_e(t) = t - \delta(t). \tag{11}$$

So far, these equations are completely general and independent of the specific shape of the cost curves. Using the above Gompertz functions, equation 6, in the definition of the delay, equation 10, gives

$$\alpha_e \exp\left[-e^{-\gamma_e(t-T_n)}\right] = \alpha_p \exp\left[-e^{-\gamma_p\left(t-\delta(t)-T_p\right)}\right], \tag{12}$$

which, upon using equation 11, gives

$$T_e(t) = T_p + \frac{\gamma_e}{\gamma_p}(t - T_n). \tag{13}$$

Using the end point condition, equation 9, gives

$$T_1' = t + \frac{\gamma_e}{\gamma_p}\left(T_1 - T_e(t)\right). \tag{14}$$

At time, t, equation 14 can be used to predict the delayed end point of the project, $T'1$, in terms of known quantities: the planned end point, $T1$; the earned duration, $T_e(t)$; and the growth parameters for the planned and earned value curves, γ_p and γ_e.

We can compare this prediction with that of Warburton and Cioffi (2016), who derived the following formula for the actual end of the project for several project profiles, including the

linear profile that is the basis for the traditional ES approach. Therefore, we refer to this as the 'standard' prediction of the project duration, T'_{1std},

$$T'_{1std} = \frac{tT_1}{Te(t)}. \tag{15}$$

Equation 14 shows that if one were to apply the standard formula (equation 15) when using Gompertz functions, one would not be using the correct expression for the duration estimate. In fact, applying the standard formula to projects represented by Gompertz functions would result in the following prediction for the final duration

$$T''_{1std} = \frac{tT_1}{T_1 + \frac{\gamma_e}{\gamma_p}(t - T'_1)}. \tag{16}$$

We note that at the end of the project, $t \to \infty$, the above prediction becomes

$$T''_{1std}(\infty) = T''_{1std}(t \to \infty) = \frac{\gamma_e}{\gamma_p}(T'_1), \tag{17}$$

and using the end point condition gives

$$T'_1 = T''_{1std}(\infty) + T'_1 - T_1. \tag{18}$$

This interesting result suggests that the standard formula may not converge to the correct answer when using Gompertz functions to model the cost profiles. This result was previously found by Warburton and Cioffi (2016), who showed that the standard formula does not give the correct answer for a project that follows the Cioffi profile.

DURATION ESTIMATE WHEN $\beta p = \beta e$

If the β parameters for the planned and earned Gompertz curves are the same ($\beta p = \beta e$), equation 10, gives

$$T_e(t) = \frac{T_p}{T_n}t, \tag{19}$$

and using the end point condition gives

$$T'_1 = \frac{tT_1}{Te(t)} = \frac{T_1 T_n}{T_p}, \tag{20}$$

which is the standard duration estimation formula. Therefore, if one were to use Gompertz functions for the planned and earned values, one could only use the standard formula if the β parameters for the two curves were the same.

We obtain a different prediction estimate when $\gamma p = \gamma e$, and these results are summarised in Table 1.

Table 1 Prediction formulas for different Gompertz parameter combinations

Case	Duration Prediction
$\beta_p = \beta_e$	$T_e(t) = \frac{T_p}{T_n} t$ $T_1' = \frac{tT_1}{Te(t)} = T_1 \frac{T_n}{T_p}$
$\gamma_p = \gamma_e$	$T_e(t) = t + T_p - T_n$ $T_1' = t + T_1 - T_e(t)$

The two-point duration prediction formula

In the early stages of the project, it is very important to be able to forecast a possible delay in order to support effective management decisions. From the above results, it is possible to construct a prediction formula that is easy to use and accurate. At the beginning of the project, we know all the parameters of the planned value curve, $Cp(t)$. On the other hand, we must assume that we know little about the earned value curve, $Ce(t)$, and so it appears wise to consider the general case. Therefore, in order to compute the duration estimates, we need to compute the parameters Tn and γe.

We now introduce a method of calculating the earned value curve's parameters by using only two data points from the project's earned value execution data. The mathematical details are contained in the appendix. We investigated a number of approaches for selecting the two data points, but using the first and last data points consistently showed the best results. Using two data points, the system of equations can be solved, and the final duration can be estimated. When we have significantly more than two values of the cumulative earned value data, we can use nonlinear regression to fit the entire earned value data set to a Gompertz function, which determines its parameters. Then, a duration forecast can be determined. Therefore, we have two methods for estimating the final duration:

1. Two-point: Estimates of the final duration are found by using the two-point method on the first and last available earned value data.
2. NR: Nonlinear regression is applied to all available data to date to estimate the Gompertz function parameters and hence the final duration.

RESULTS

To test the effectiveness of the above methods, we generated synthetic data sets for the planned, earned and actual data rates. Planned value data rates were generated by using Gompertz distribution functions, $g_p(t)$, with parameters similar to those found in real projects (Narbaev and DeMarco, 2014b). We then added a random uniform distribution of noise to get the earned value profile, $g_e(t)$, and the actual profile, $g_a(t)$. Many example data sets were generated, and the duration and cost predictions analysed using the above methods.

A typical example of the cost rate profiles is shown in Figure 3, where significant randomness is evident in the earned value and actual cost rates. The corresponding cumulative cost profiles are shown in Figure 4, where the randomness is smoothed out by the effect of the cumulative computation.

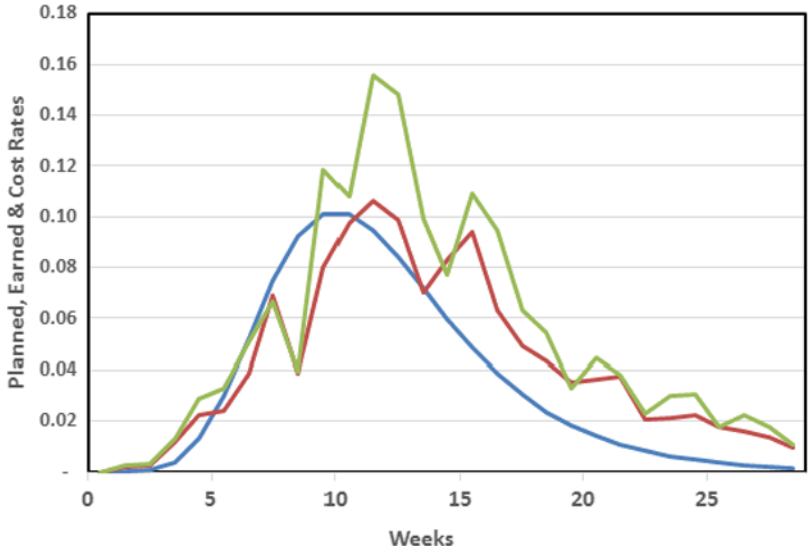

Figure 3 An example of Gompertz distribution functions, with noise, for planned value rate, $g_p(t)$, (blue), earned value rate, $g_e(t)$, (red) and actual cost rate, $g_a(t)$, (green)

The accuracy of the two duration prediction methods is shown in Figure 5, which plots the errors in the duration and cost estimates as the project proceeds. For the two-point method, we used the first data point and the last data point available, that is, at the current time of the prediction (red curve). The regression method used a nonlinear regression fit to all available data at that time (blue curve). For comparison, the error in the standard cost estimate at completion (*CEAC* = *Budget/CPI*) is also shown (green curve).

There are several interesting features of figure 5. The prediction errors generally decrease as the project proceeds and the duration error falls below about 10% after about 20% of the planned duration. The duration error falls to around 5% after about 30% of the planned duration.

Next, we varied the random contribution in the earned value and actual cost distributions. Somewhat surprisingly, addition of more randomness to the data did not significantly increase

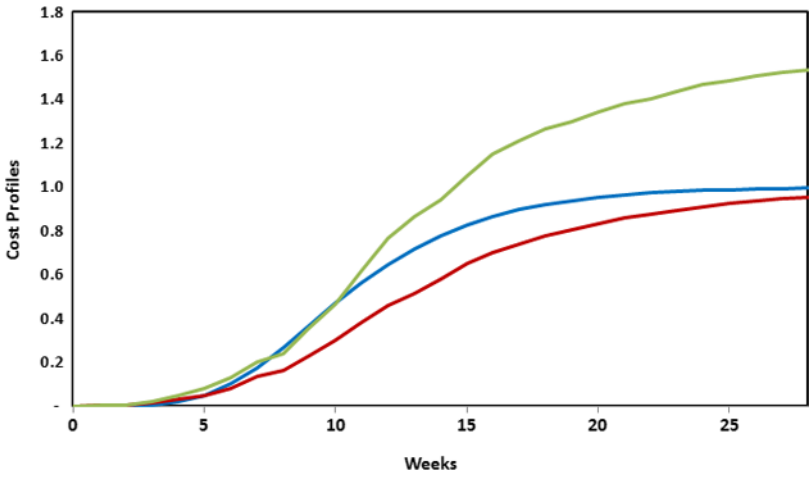

Figure 4 Corresponding Gompertz functions to those of figure 3, for cumulative planned value, $G_p(t)$, (blue), earned value, $G_e(t)$, (red) and actual cost, $G_a(t)$, (green)

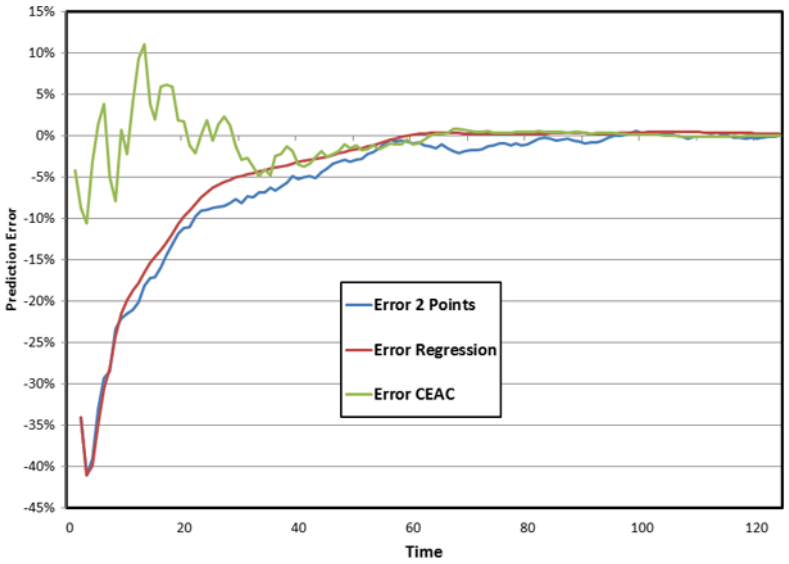

Figure 5 Errors in the estimation of the final duration (two-point method, red; regression, blue) and cost (CEAC, green)

the prediction errors. This is shown in figure 6, which summarises the results. It appears that the averaging effect of the cumulative data effectively smoothes out the deviations. This suggests that a major contribution to duration errors may be associated with biased deviations rather than random deviations, in the earned and actual cost data – a result that needs further exploration.

Conclusions

Using the standard definitions of EVM and ES, we established a sound theoretical basis for the prediction of the project duration when the cumulative cost profiles follow a Gompertz function. We derived formulas for the duration estimates and found the important and interesting result that a simple two-point estimation formula is effective in predicting the duration.

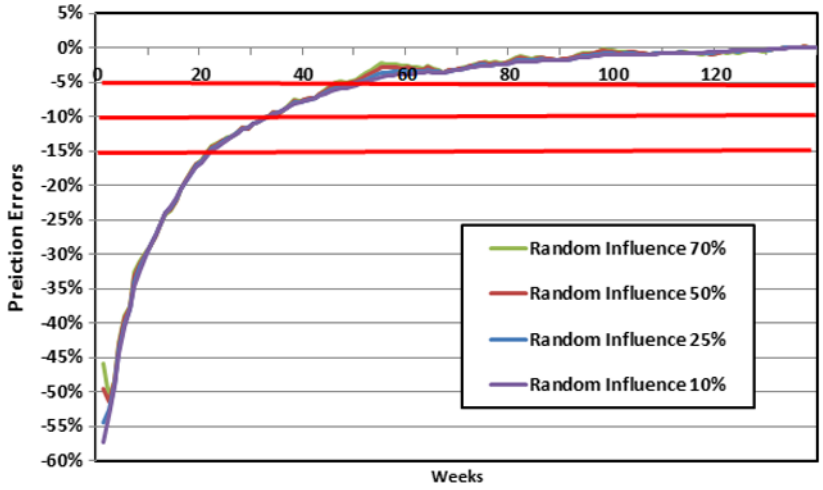

Figure 6 The effect on the prediction error of increasing the random influence is small for quite a wide range of randomness. Where the predictions cross the red lines highlights where the errors fall below 15%, 10% and 5%.

Table 2 summarises the results by providing the prediction errors over time through the project.

Table 2 The decline in the prediction error as a percent through the planned project

Duration Prediction Error	Percent of Plan
15%	15%
10%	20%
5%	35%

Because the entire theory was built on standard EVM and ES definitions, it is proposed as a familiar and accessible methodology for project management practitioners. Also, while the derivation of the error formula was moderately complex, the resulting two-point formula is quite straightforward, especially if compared to some previous studies that require three time points for curve fitting (Narbaev & DeMarco 2014b).

There are several issues that could be explored in future research. One might extend this work to other cost profiles, such as the Cioffi (2005) profile and the trapezoidal profile often used in construction (Warburton 2014). In addition, it might be possible to extend this theory to analyse the impact on the estimates of scope growth during execution. Typically, such methods incorporate estimates of extra work and scope changes needed to increase the project's expectations relative to its original performance. Further investigation might also provide guidance on the selection of appropriate cost profiles and, in particular, the effectiveness of using of Gompertz functions to characterise different categories of projects and industries.

In conclusion, we established a new, effective method of duration and cost estimation over time and validated the theory by comparing its predictions to many synthetic projects. The duration and cost error formulas are quite simple and require little additional effort to be practically useful to project teams during project monitoring and control.

Appendix: Mathematical details

We define two times for which we have earned value data, t_1 and t_2 (t_1, $t_2 > 0$ and $t_1 < t_2$). We also know the earned value data at the two instants of time, $C_e(t_1)$ and $C_e(t_2)$. For these two time values, we calculate the earned duration, $T_e(t)$, from $C_e(t) = C_p(t - \delta(t)$, as

$$T_e(t) = T_p - \frac{1}{\gamma_e} \ln\left[-\ln\left(\frac{C_e(t)}{\alpha}\right)\right]. \tag{21}$$

Once the $T_e(t)$ values are determined, we can calculate T_n and γ_e and thus T'_1 in two different ways, but the different approaches lead to essentially the same results.

The first method, called the two-point method, uses the properties of linear functions and allows defining the parameters a and m as

$$T_e(t) = a + m*t. \tag{22}$$

We develop a two-equation system where the $T_e(t)$ values are estimated from equation 21.

$$\begin{aligned} T_e(t_1) &= a + m\ t_1 \\ T_e(t_2) &= a + m\ t_2. \end{aligned} \tag{23}$$

After solving the system, we estimate T'_1 as

$$T'_1 = \frac{T_1 - a}{m}. \tag{24}$$

When we have several values for the cumulative earned value data, we perform a nonlinear regression on the entire earned value data set to determine the parameters of the Gompertz function. The estimate of the duration forecast then follows.

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CONFERENCE PAPER

Multilevel approach for Real Options in the innovation management process: integrating project, portfolio and strategy

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Synopsis

The Real Options approach used by innovative firms has been largely studied considering three different levels: strategy level, innovation portfolio level and project level. The theoretical discussion, however, is still unclear about how to integrate these three levels. The main goal is to identify how it is possible to integrate the Real Options approach on project, portfolio and strategy levels.

Research design

Based on four in-depth case studies and on grounded research in companies in Brazil, where we have longitudinally accompanied specific projects, we propose a discussion on the main

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issues behind different forms of integrating strategy, portfolio and project, using the Real Options approach.

Relevance for practice

We believe that the integration between these three levels in using Real Options is crucial to comprehend organizational aspects and mainly to capture the value of managerial flexibility. This value is added by the Real Options approach when compared to traditional financial approaches (as net present value and return on Investment).

Main Findings

We provide links among the issues treated separately in the literature: strategy, portfolio and project management. For instance, we show how flexibility might increase (or not) in the three levels and the alignment (or not) among these levels. We also find that the managerial flexibility should not be treated exclusively at the project level (different from the current thinking on the innovation literature) and should be considered at different levels. Furthermore, we claim that the portfolio architecture should be linked and influenced by strategic Real Options, which implies important changes in the portfolio management process.

Research implications

Our paper also indicates the open space for the development of contingency models that aim to align the use of Real Options in the three perspectives described and the refinement of the managerial mechanisms to balance the different arrangements each level has.

Keywords

Real Options, Strategy, Innovation Portfolio, Project Management

Introduction

The use of the Real Options approach to valuate projects with a higher innovation content has attracted the attention of academics and practitioners in recent years (Barnett 2005; McGrath 1997; Wang & Wu 2015). To conduct this study, we adopted the concept of Real Options set by Dixit and Pindyck (1994) and adapted by Adner and Levinthal (2004, p. 75): "Real options investments are characterized by sequential, irreversible investments made under conditions of uncertainty."

In this theme, the scholars have explored a vast agenda of research. For instance, enhancing the mathematical models to apply the approach to different kinds of innovation projects (Wang & Yang 2012); discussing the organizational aspects linked to the use of Real Options (Coff & Laverty 2007); and analysing the contributions of Real Options to understand strategic investments (Krychowski & Quélin, 2010). Furthermore, the literature has addressed the Real Options thinking in different streams of research, comprised in three different perspectives: project valuation and project management (at project level), innovation portfolio (at portfolio management level) and strategic investment management (at strategy level).

At the project level, for instance, Huchzermeier and Loch (2001) focused their work on employing Real Options as an alternative for valuating and managing R&D projects. At the

portfolio management level, Santiago and Bifano (2005) investigated how Real Options might be applied to support innovation portfolio. Paulson, Connor and Robeson (2007) proposed the insertion of Real Options logic on the elaboration of portfolio management tools. Klingebiel and Adner (2015) and other scholars looked at Real Options at the strategic level, developing analysis including not only the use of Real Options on the financial point of view but also the application of its underlying principles and logic – *Real Options Reasoning (ROR)*.

By Real Options Reasoning, we consider "a conceptual approach to strategic investment that takes into account the value of preserving the right to make choices under uncertain conditions" (McGrath & Nerkar 2004, p. 1). In this paper, we developed an approach integrating such different perspectives to support substantive and radical innovation management. This integration is necessary, once the Real Options approach has been used in several ways in the literature, thus proving its potential as a relevant project management approach (Adner & Levinthal 2004; McGrath, Ferrier & Mendelow 2004).

As consequence, the research question that guides this paper is as follows: How might the Real Options approach be integrated at the project, portfolio and strategy levels? We perform a literature review on Real Options in order to develop a comprehensive framework focused on the integration of the approach on strategic, portfolio and project levels. In addition, we conducted a multiple longitudinal case study in four Brazilian firms which pursued managerial mechanisms on their innovation management system that uses Real Options or Real Options Reasoning. After Perlitz, Peske and Schrank (1999) pointed out the implementation issues in applying Real Options for R&D valuation and questioned why the method was not the standard in industry, Barnett (2005) and Tong and Reuer (2007) recognized that the organizational and managerial aspects of using Real Options are frontiers in this research field.

Our work contributes to a discussion of the relationships between the different levels in which the Real Options approach is used in activities with regard to innovation management. We believe that the fit between the levels of analysis in using Real Options is crucial to comprehend the implementation issues related to organizational and managerial aspects and mainly to capture the value of managerial flexibility. This value is added by the Real Options approach when compared to traditional financial approaches (as net present value and return on investment). The main goal was to identify how it is possible to integrate the Real Options approach on project, portfolio and strategy levels. In the first section of this paper, we develop a literature review on Real Options, with sections on project level, program management level and portfolio level. Then we describe the methodological aspects of the research, present the results and discuss them and at last, we conclude arguing about theoretical and practical implications of our findings.

Theoretical background

REAL OPTIONS AT THE PROJECT LEVEL

Because Options Theory was first set on financial markets (Black & Scholes 1973; Cox, Ross & Rubinstein 1979) and extended to the real environment (Dixit & Pindyck 1994; Luenberger 1998; Trigeorgis 1996), several scholars dedicated their work to developing new mathematical models derived from them, and applied them to different contexts. Conceptually, an option is a right, not the obligation to buy or sell a good at a point in the future. The possibility to wait for new information and make the decision more assertive generates so-called "managerial flexibility," which can be quantified and has a specific value. The idea

considers that the uncertainty on projects' payoffs increases the value of the "Real Option" and improves the general value of that project when compared to traditional valuations based on NPV – net present value (Huchzermeier & Loch 2001).

With respect to R&D projects, and more broadly innovation projects, the development of mathematical models based on Real Options had been appointed as an adherent to valuate the projects, highly surrounded by uncertainties (Perlitz et al. 1999). In this sense, Huchzermeier and Loch (2001) analyse the influence of different sources of uncertainty on innovation projects and the value of managerial flexibility. Santiago and Vakili (2005) continued on the same road in developing this model, and Santiago and Bifano (2005) used an approximated model to valuate a development project of electronic devices. Schwartz (2004) applied Real Options to valuate patents. McGrath and Nerkar (2004) looked at models to use Real Options on pharmaceutical firms. More recently, several scholars have worked on elaborating models for specific markets or technologies (Wang et al. 2015; Wang & Yang 2012).

In general, at the project level the use of Real Options is focused on developing and applying mathematical models intending to capture the managerial flexibility of a project and to produce a better value than traditional alternatives predicts (as NPV) to improve decisions during the project development process. Should the project be interrupted? Improved? Abandoned? The logic behind the methods, related to the elaboration of decision trees and the identification of critical uncertainties is aligned with the needs the innovation management imposes.

REAL OPTIONS AT THE PORTFOLIO LEVEL

The portfolio management of innovation projects has been discussed with a view to selecting projects on a portfolio and balancing resources on these projects in an optimal way (Cooper, Edgett & Kleinschmidt, 1999). The architecture of the portfolio involves considering its strategic buckets, the rules to characterize each portfolio and to rank the projects, the support to decisions and the resources re-allocation as some of the macro activities of portfolio management.

Regarding Real Options at the portfolio management level, the literature prescribes actions with respect to (i) the need for a concrete project valuation to compare different initiatives inside the same bucket and the possibility of Real Options to fit it (Cooper et al. 1999); and (ii) evaluation tools that internalize the assumptions of Real Options, but translate them to qualitative scores (Paulson et al. 2007; Terwiesch & Ulrich 2008). In this way, Mathews (2010a, 2010b) developed an algorithm and a managerial procedure based on Real Options parameters to classify and quantify pre-development ideas and product concepts.

Another stream of research focuses on developing Real Options mathematical models to optimize the project selection and to minimize risks and hedge against uncertainties. Wang and Hwang (2007) formulated the portfolio selection problem using fuzzy programming. Van Bekkum, Pennings and Smit (2009) analysed R&D projects as call options and studied the effect of project conditionality and correlation on the risk of a portfolio of projects. Lo Nigro, Morreale and Enea (2014) developed a Real Options model to select which project to finance in a portfolio, considering open innovation possibilities.

At the portfolio management level, Real Options approach is used not only to valuate a single project but also to analyse a portfolio of projects and support the decision-making on which the management should focus. Using analytical tools or Real Options mathematical models, the intention is to address the managerial flexibility – not that one present in one

project, but the flexibility in selecting and reallocating scare resources between projects. The project portfolio is seen as a Real Options portfolio.

REAL OPTIONS AT THE STRATEGIC LEVEL

A stream of research has been conducted on the use of options logic at the strategic level and is related to the strategic choices or investments an organization (McGrath & Nerkar 2004). The application of Real Options on strategy is called as Real Options Reasoning (ROR), considered as "a conceptual approach to strategic investment that takes into account the value of preserving the right to make choices under uncertain conditions" (McGrath & Nerkar 2004). The ROR considers the underlying principles that Real Options explicitly shows at the project level and translates it to a higher level of investment. As a consequence, a firm can "engage uncertainty and benefit by investing in options to respond to uncertain futures by managing the investment in a sequential fashion as uncertainty is resolved" (Tong & Reuer 2007, p. 3). Investments could be R&D, internationalization, diversification, new business development and so on.

Tong and Reuer (2007) discuss the contribution of Real Options to strategic management in three paths: (i) Real Options forces the re-analysis of the constituted wisdom and present specific predictions on a firm's choices; (ii) Real Options sets an imbalance in the structure of payoff for the potential investments that pursue options, reducing downside risks and favouring upside opportunities; (iii) Real Options influences and clear the resource allocation process of the company informing strategic decision-making.

Klingebiel and Adner (2015) and Barnett (2008) affirm that, because of the rigour and methodological complexity of Real Options mathematical valuation methods, this approach had its decision rationale of investments utilized as a heuristic and guide for management decisions and strategy formulation. Three elements of resource allocation regimes that characterize the ROR are (i) sequencing; (ii) low initial commitment; (iii) re-allocation (Klingebiel & Adner 2015). The use of options framing for decision-making under uncertainty, for instance by using small initial investments and assuming riskier projects, produces strategic flexibility, permitting managerial intervention that generates higher upside potential and contains downside losses (Barnett 2008). Instead of following the traditional decision-making framing, which indicates avoiding riskier projects, ROR drives to riskier investments; that is, in this case, uncertainty produces value.

REAL OPTIONS FRAMING: PROJECT, PORTFOLIO, STRATEGY

Each of the three different levels of analysis in which Real Options is applied has its dynamics and managerial processes. On the other hand, innovation management, especially that responsible for the inducement of more radical management, requires a complex system that comprehends project, portfolio and strategy levels (O'Connor, Leifer, Paulson & Peters 2008). As long as Real Options is appointed as an important approach to make viable the management of innovation (Barnett 2005; Huchzermeier & Loch 2001; Lo Nigro et al. 2014), there is the necessity of a better comprehension about the relationships between the use of Real Options logic, considering a vertical court on the three levels. To permit the analysis of Real Options at the different levels, Table 1 exhibits a summary of what has been discussed in the previous sections.

Table 1 Real options at project, portfolio and strategic levels

	Logic	Source of Managerial Flexibility	Managerial Alignment
Strategic Level	Real Options Reasoning: low initial commitment, sequencing, resources re-allocation	Possibility to assume high potential returns in strategic investments through the containing of failing projects and taking riskier ones with controlled downside risks.	Strategic Planning and Strategic Actions
Portfolio Level	Re-allocation criteria to distribute resources between projects	The possibility to reallocate resources and select projects to compose optimal portfolio.	Portfolio architecture, composition and distribution
Project Level	Critical uncertainty identification and project modelling	Possibility to interfere on the course of the project, improving it, abandoning it or deferring it.	Sequential and "stage-gated" project management

Source: The authors

Methodological aspects

We have proceeded to a multiple case studies. Our main research question was: how does the Real Options approach might be integrated at the project, portfolio and strategy levels?

Considering this focus, we investigate in deep the reasons why firms or, more specifically, some managers, are trying to adopted a Real Options approach, considering this three levels. We have proceeded to longitudinal studies and accompanied some projects during a large period. Regarding the methodological aspects, we followed the recommendations of Eisenhardt and Graebner (2007), Eisenhardt (1989) and Voss, Tsikriktsis and Frohlich (2002) to proceed multiple case studies, characterizing an inductive work, once we would like to build theory from empirical analysis. Because of the long time innovation projects take to be developed, we conducted longitudinal analysis, following the planning and execution of several innovation projects on four different Brazilian companies, recognized by their innovation driven actions.

The same company can have different innovation projects, some incremental, and some radical. Besides, often there are different portfolios (R&D projects, process or product improvements, etc.) and projects differently evaluated in the same portfolio (because of balancing objectives). Nevertheless, to study projects demands also to consider the company.

We intentionally selected companies with established innovation management systems and that had contact with the Real Options approach to valuate innovation projects. It was necessary understand how this approach was inserted on the management system and the relations for dealing with strategy, portfolio and project management. They were followed

Table 2 Research overview: cases and instruments

Case	Brief Description	Period of Research	Research Instruments/ Protocol
C1	Brazilian company that develops and manufactures cosmetics. Considered one of the 10 most innovative companies in the world.	2012–2015	Interviews and discussion with the innovation manager.
C2	German-Brazilian company that develops and manufactures components for automobiles.	2012–2015	Interviews and discussion with the VP of R&D for Brazil and the innovation manager.
C3	Brazilian textile company that develops and manufactures tissues	2012–2016	Interviews and discussion with the CEO and the innovation manager.
C4	Brazilian textile company that develops and manufactures tissues	2012–2015	Interviews and discussion with the CEO and the innovation manager.

Source: The authors

longitudinally during a huge research project which investigated several aspects of the management of project with high uncertainty.

To collect data from the companies, we followed their activities longitudinally among the management of specific innovation projects, participated on selection and prioritization committees, and interviewed project managers and portfolio managers using semi-structured scripts. We have researched projects in five companies, as shown in Table 2.

Results and discussion

As the literature presented at the beginning of this work suggested, in our sample, we found firms with different capabilities associated with strategic planning, portfolio management and project management (see Table 3). We also observed that the firms have different aspects associated with the Real Options thinking and approach. In C1 and C2, the strategic planning involves scenario analysis, roadmapping process, market analysis and benchmarking and as a result, the strategic planning provides contingency plans for different markets and technology configurations. In these firms, the strategic planning was not conceived to explicitly increase the managerial flexibility (this is not an explicit concern of firms' board), but such process helps defining a temporal sequence for exploiting the opportunities, adopting well-defined

Table 3 Processes related to each level of analysis

Level of Analysis	C1	C2	C3	C4
Strategic	Formal strategic planning, applying scenarios and roadmaps	Formal strategic planning, applying scenarios and roadmaps	Formal strategic planning applying SWOT analysis, Porter Five Forces.	Formal strategic planning
Portfolio	The firm has three portfolios: new products, new technologies and new process	Different portfolios for distinct innovation portfolios (e.g. technology, product, process)	The firm has two portfolios: new products and new process	The firm has one portfolio related to new product development
Project Management	The firm has two processes: new products and new technologies	Different innovation process for different types and degrees of innovation	Only the new product process is formalized	The firm has a well-established process for new product development

Source: The authors

heuristics for resource allocation: following experimentation logic, the managers use low early commitment resources at the initial phases of exploiting opportunities. The opportunities are not treated as options.

Although C3 and C4 have not employed a well-structured strategic planning process, their outcomes of strategic planning also helped to define a temporal sequence for exploiting identified opportunities. At the portfolio level, we also found substantive difference among the firms. For instance, C2 has five different portfolios, include one (incubation) for exploring radical innovation opportunities. C2 also has clear rules for defining a temporal sequence for performing the projects and the allocation of resources following the logic of minimizing the losses (e.g. low early resources commitment). In three firms (except C4), there is a well-structured process for reviewing the portfolio according to the evolution of projects and the emergence of new information.

We argue the integration (link) among strategy, portfolio and project management might be related to three aspects: managerial flexibility, managerial attention and deployment of options.

Our findings support that firms have different patterns of integration (link) among the strategy, portfolios and projects about managerial flexibility:

1. The strategic planning might generate limited flexibility, consequently impacting on the capacity of portfolio and project management to improve managerial flexibility. For instance, in C4 the strategic plan does not address new business and innovation opportunities, focusing on expanding the current market position and exploiting the current resource basis. Similarly, in C3 managers do not consider, during strategic

planning, opportunities for entering into new markets. In such cases, the strategic plan compromises the breadth of options and diversification of options. In all cases, managers have difficulties in investing in riskier projects. The managers have considerable difficulties in justifying investments on the opportunities related to radical innovation projects. Strategic planning does not offer proper heuristics to experiment without compromising a considerable amount of resources. In the four cases, managers do not have a well-defined heuristics for re-allocation of resources. Also, the managerial attention on the evolution of options is underdeveloped. There are not processes for identifying, analysing and taking decisions related to the options. Strategic reviews are only analysed during review moments, and the main concerns are the budget and time scheduling.

2. Strategic planning generates managerial flexibility, but the portfolio constrains such flexibility, and vice versa. First, it occurs when there is not a fit between the breadth of options and the types of portfolios. For instance, in the case of C4, the firms had ideas related to new business models, but their portfolios involved only new incremental product development. In C2, the managers decided to create a specific portfolio for exploring more radical innovation opportunities identified during the strategic planning. This example refers to the managerial flexibility created at the strategic level and might reflect the structure of portfolios. Second, the firms might not have heuristics that allow the firm not to compromise a considerable amount of resource at the beginning of projects. In C2, the traditional approach for defining the project's budget was to consider all resources required to perform the project. Using traditional approaches, such as NPV, managers did not consider the alternative of allocating a minimum amount of resource necessary for trial-and-error learning experiments. Similarly, C3 and C4 also planned the entire project life cycle. Third, the portfolios were not aligned with strategic actions and intentions.
3. The portfolio generates managerial flexibility, but the project management constrains such flexibility. It might occur when the project follows a predefined linear sequence of activities instead of the logic of a decision tree, paying no attention to the alternatives (options) that emerge during the project life cycle. We found a such pattern in C1, C3 and C2.

The second link identified among the three levels in our cases is related to managerial attention, which involves the ability to focus on the options, to identify and analyse the emergence of information and to change the course of action. It might occur between strategic and portfolio when the update of the portfolio does lead to an update in the strategic plan (e.g. C3) and vice versa (e.g. C4). Similarly, new information is identified at the project level, and the firm has proper communication chains and decision-making processes which allow analysing the impact on the portfolio and strategy.

The third link consists of the ability to deploy the strategic action as an option (or a portfolio of options); further, each strategic option should be treated at the project level as a set of other options. The update of new options that a project generates at each decision point and the changes performed at the strategic level should be linked in a flow of information and managerial mechanisms, to permit the company to keep its coherence. Regarding this aspect, the innovation portfolio and its management should ensure that the link is built. The strategic elements define and correct distribution of projects in them in a dynamic process, guaranteeing the value of managerial flexibility at the strategic level.

Conclusions

IMPLICATIONS FOR THEORY

Our findings have a number of implications for theory. First, we provide links among the issues treated separately in the literature: strategy, portfolio and project management. Based on the three cases, we found that managerial flexibility, managerial attention and the deployment of options bridge these three levels. We show how flexibility might increase (or not) in the three levels and the alignment (or not) among these levels. We also show that the managerial attention might be a useful link among these levels and these required appropriated communication chains and integrated decision-making processes. The misalignment in using the Real Options approach in each of the three levels and the different comprehension each of them has about the managerial logic behind the elaboration of the options are perceptive on the treatment of each theoretical perspective put on the theme.

We also find that the managerial flexibility should not be treated exclusively at the project level (different from the current thinking on the innovation literature), and should be considered at different levels. It is clear in the literature that the use of Real Options approach to structure and manage projects produce managerial flexibility (Huchzermeier & Loch 2001), but the consideration of the possibility to change the course of the projects and the implications it has to strategy and portfolio management might be extended.

Another point we indicated is that the portfolio architecture should be linked and influenced by strategic Real Options . This implies important changes in the portfolio management process. For instance, the portfolio might be organized in different project buckets, considering the options they can generate for the company (e.g. abandoned projects, improved projects, licensed projects). The portfolio balancing logic moves from the traditional incremental versus radical projects to a Real Options logic. The rule of balancing takes into account the different strategic options the firm constituted with its projects.

At last, we argue that project management should be organized according to Real Options logic. The project sequencing might consider different options instead of a predefined flow. The project management system should include, for instance, the draw of decision trees, evaluation and decision gates, and the process of changing direction the options logic requires.

Our work indicates, in the end, the open space for the development of contingency models that aim to align the use of Real Options in the three perspectives described and the refinement of the managerial mechanisms to balance the different arrangements each level has.

IMPLICATIONS FOR PRACTICE

Our work provides some relevant insights for practice. The disperse way Real Options are treated across different organizational levels entails the search for managerial mechanisms to link them. The strategic planning tools do not consider the presence of options, and are driven by competitive-advantage thinking. In dynamic environments, in which there is a need for taking more risky projects, this logic has no more adherence, making the Real Options approach an important heuristic for strategic formulation. To make it palpable, a competency to map strategic investments as a set of options and, more importantly, the organizational disposal to kill or abandon projects and established strategic actions are indispensable.

Translating strategic options to an innovation portfolio requires a well-designed configuration of project buckets. The buckets should address the significance of each strategic

option and support the alignment across projects in a way such that the strategy options can be visualized and achieved between them. The guarantee that each portfolio has resources and organizational protection makes the strategy possible, as the re-allocation of resources is feasible and manageable. In this sense, the link between the innovation portfolio and the strategy should be the deployment of the strategic options in buckets composed by the projects responsible for making the strategy achievable. The managerial flexibility at portfolio level only has value if the flow between portfolios occurs and if the portfolios represent specific strategic options.

Between the portfolio level and project level, the link is materialized, first, at the moment the projects are inserted in one of the portfolios, and second, when, during the sequential and "stage-gated" management of them – based, for instance, in decision trees – the decision-making directs the project to another portfolio or generates new options inside the projects. However, the project produces managerial flexibility individually, and this value only becomes real if it produces strategic value for the firm. The interaction between project and strategy levels also needs to be balanced, and the flow of projects fuelling the set of strategic options, as well as the strategic options becoming projects, may be constant and equalized by portfolio management.

Our work indicates that to migrate from the sustainable competitive advantage logic to a transitory competitive advantage, an important step is linking strategy, portfolio management and innovation project management. Real Options logic is a relevant approach to performing this task, integrating these three levels and establishing management mechanisms to produce and realize the value of managerial flexibility.

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CONFERENCE PAPER

Aggregating Project Level Performance Data into Organization and Industry Insight

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Synopsis

This research article is an initial examination into a performance measurement system recently introduced in the Norwegian construction industry. The 10–10 Performance Assessment Program developed by the Construction Industry Institute has been created to meet the growing demands for a more comprehensive benchmarking and measurement system in the construction sector. Empirical analysis has been conducted on real project data from 14 Norwegian companies that were invited to use the system in order to better monitor and improve their project success.

Research Design

The design of this study is primarily quantitative in nature given that project data gathered as part of the 10–10 system was explored in regards to seeing whether there were any significant correlations between the various components of the system consisting of input measures, output measure, survey questions and project characteristics.

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Relevance for practice and education

Projects play an integral role in many industries and therefore being able to better monitor and improve their chance of success is of high value to society. Through the analysis in this article, a better understanding has been obtained of factors that can help projects succeed within the construction industry as well as other industries on a broader scale.

Main Findings

The findings reveal that there were several key metrics of the 10–10 system that were strong indicators of cost overrun in the project. These indicators spanned a wide variety of areas such customer satisfaction, project team competence, and relationships between various project stakeholders among others. Additional findings have also been discussed in line with future research efforts and the construction industry's need for broader sector analysis.

Research Implications: The 10–10 performance measurement system can be leveraged to improve project not only on an individual project level but on the aggregate organizational and industry levels as well. Identifying and utilizing such performance systems that are able to interconnect these various levels is key towards carrying out more successful projects in the future.

Keywords

Performance Measurement, Construction Industry, Project Management, Project Success

Introduction

Many performance measurement systems are being utilized today in the construction sector, some of which are arguably more effective than others. In the construction industry, the three most used performance measurement systems are the European Foundation for Quality Management (EFQM) excellence model, the Balanced Scorecard (BSC) model, and the Key Performance Indicators (KPIs) model (Yang et al. 2010). A challenge facing many organizations today is selecting the right performance measurement system to meet the various internal and external demands. At the same time, globalization and an increase in competition in the international markets requires there to be a broad overview for how the industry is performing on the sector or national level to sustain competitive advantage. There is a need to develop a more comprehensive performance measurement framework that better suits the construction industry (Bassioni, Price & Hassan 2004; Neely & Adams 2001).

The Construction Industry Institute's (CII) 10–10 Performance Assessment Program is a performance measurement system that was originally developed in the United States in 2012 in order to help managers of construction projects improve and better monitor the success of their projects. The 10–10 system works by creating 10 leading indicators (input measures) and 10 lagging indicators (output measures) based on anonymous responses to surveys sent out to project management team members. The underlying idea is that poor performance in the input measures as compared to industry benchmarks created by the aggregate scores of the entered projects is cause for concern where corrective action needs to be taken; otherwise the output measures and ultimately project performance will suffer as a consequence. The ten input measures are created from the scores of a series of approximately fifty questions given in the survey asking the project team members about various aspects of the project. The exact

weighting function and which questions are mapped to which input measure is decided by the CII administrators based on their extensive industry experience. The ten measures are: planning, organizing, leading, controlling, design efficiency, human resources, quality, supply chain, safety, and sustainability. The questions that form the basis for the input measures are typically more subjective in nature and include relationship based or interpretive questions in contrast to the output measures that are objective measures such as time delay or cost overrun.

One of the challenges when implementing a performance measurement system in the construction industry is that is very much project-oriented, where although projects may involve similar sets of processes, each one could be considered a prototype with many distinct features (Wegelius-Lehtonen 2001). Thus, creating a comprehensive performance measurement system that is effective across many types of construction projects can prove to be a difficult task. The 10–10 system offers a possible remedy by tracking projects according to phase instead of just at completion. The advantage in doing this is that it is more readily possible to proactively improve project performance as warning signs can be systematically identified and acted upon. This is an evolution of the previous performance assessment system (PAS) designed by CII that only provided feedback at project closeout and was much more retrospective in nature. The five phases making up the 10–10 system in order from earliest to latest are: front end planning, engineering, procurement, construction, and start-up. Additionally, separation by phase helps to reduce variability in the analysed projects, as there are fewer factors to control for as well as offering possible analysis at a phase level.

The aim of this paper is to test the 10–10 system by conducting an initial empirical analysis on Norwegian construction projects that have been entered into the database thus far. A variety of relations between the input measures, output measures, project characteristics and key survey questions have been briefly discussed, as well as applicability to organizational improvement efforts and broader industry analysis needs. The long-term objective for the research project is to extract recommendations to be used as the basis for a set of tools for performance measurement in the construction industry. The 10–10 system was tested to see its capacity to meet both process- and project-level improvement efforts and to identify performance drivers and their effects, as well as to see how project-level data can be exploited at an aggregate measurement level. More explanation about the distinction between these levels of measurement and performance measurement follows in the next section.

Theoretical framework

What exactly is a performance measurement system, and how should an organization go about selecting one that fits its needs best? Neely, Gregory and Platts (1995) describe a performance measurement system as "the set of metrics used to quantify both the efficiency and effectiveness of actions." This is a very broad definition and begs many questions such as which actions should be chosen to be measured, on what level the measurement should take place and what type of measurements are best suited to accomplish the task. Takim, Akintoye and Kelly (2003), for instance, classify performance measurement along three general dimensions that include quantitative or objective measures, qualitative or subjective measures, and what or whose performance is being measured. Performance measurement is fundamentally about identifying areas for business improvement, which can be done in a variety of ways.

When it comes to the type of measures that are to be used, there is a strong consensus that a balanced system needs to be employed that takes into account both quantitative and qualitative measures (Anderson & McAdam 2004; Atkinson, Waterhouse & Wells 1997).

These measures are dependent in large part on what the organization hopes to get out of the system. Furthermore, a performance measurement system is not necessarily effective just by including both types of measurement. It is crucial to be able to see that there is a cause-and-effect relationship between non-financial and financial indicators that drives such improvement in performance and is ultimately tied to the strategic goals of the organization (Robinson et al. 2005; Kaplan & Norton 1996). Effectively utilizing both types of measurement and linking them to the organizational goals is a key component in having a comprehensive performance measurement system.

In terms of levels of measurement, there are two broad areas to consider: measuring on an activity level versus measuring on an aggregate level. Measuring on an activity level deals with improvement at a business process or project level, whereas measuring on an aggregate level is more about examining and comparing performance at a higher national or sector level. Productivity is currently one of the more commonly used measurements for performance and is one of the primary measurement methods used on an aggregate level.

One of the main concerns when using aggregate-level measurements is that they do not translate very well into understanding the level of performance for individual companies. Goodrum, Haas and Glover (2002), for instance, discuss the discrepancy between aggregate- and activity-level productivity estimates in the U.S. construction industry from 1976 to 1998. Even though productivity measurements showed a decline on the aggregate level over this time period, activity-level measurement data compiled from 200 construction activities over the same time period revealed the opposite. This difference shows that aggregate-level measurements may not be a reliable indicator of actual performance in the industry. At the same time, it is important for policymakers to have aggregate-level measurements in order to be able to get a broad overview for how the industry is doing, as the construction sector forms the core of a nation's wealth (Muya et al. 2013). However, because of the difficulty in being able to connect these broad aggregate measurements to a more operational level, companies have looked elsewhere for measurements that are more applicable to their own performance (Harrison 2007).

Activity-level measurements are much more relevant for companies in this regard, as direct improvements can be implemented more readily as a result of such measurements. Activity-level measurements can be further broken down based on the level they target. According to Yang et al. (2010), a review of performance measurement studies in the construction industry from 1998 to 2009 found that there are three distinct levels being discussed: the project level, the organizational level and the stakeholder level. In the construction sector, the emphasis has been on performance measurement on the project level because of the nature of the work. Originally, performance measurement in construction was primarily about project performance in terms of time, cost and quality (Ward, Curtis & Chapman 1991). Lin and Shen (2007) reviewed performance measurement studies in the construction industry from 1998 to 2004 and found that 68% of the papers looked at performance measurement at the project level. Furthermore, the dimensions of measurement have also expanded to include softer areas such as the environment, health, safety, customer satisfaction, human resources, technological innovation, and so forth. Nevertheless, this emphasis on the project level brings up a few concerns; namely, that its focus is possibly narrow with respect to examining harder issues or quantifiable measures; retrospective in looking back at previous performance; and bottom-line driven or overly focused on short-term gains (Love & Holt 2000). Pillai, Joshi and Rao (2002), for instance, suggest an integrated performance measurement system that links performance metrics across the project selection, execution and implementation phases, rather than just

examining the phases in isolation, to combat such a narrow focus. In this manner, resources will be more effectively allocated, and projects will better be able to meet organizational goals by utilizing a more holistic performance measurement approach.

More recently, there has been a shift to more organizational-level measurement as companies try to address the need for more aggregate-level measures (Bassioni, Price & Hassan 2005). Measuring on an organizational level gives the advantage of offering a better picture of how a company is positioned in the marketplace and whether they have a competitive advantage in certain aspects of their business that may be difficult to evaluate when measuring on a purely project level. Stakeholder-level measurement, on the other hand, is about judging performance from different stakeholder perspectives, which is also important to take into account. Wang and Huang (2006), for example, found that there is a significant relationship between the owner's, supervisor's and contractor's performance and criteria of overall project success. A comprehensive performance system should be able to address the need for both activity and aggregate-level measurements. Additionally, taking into account various types of activity measurements helps to create a more robust framework for performance measurement.

Research methods

The research conducted in this paper has been carried out as a result of a formal search conference in the Norwegian industry to find ways to improve the performance of the construction sector. The research project began in 2013 and currently has funding until 2017 by the Norwegian Directorate for Building Quality (DiBK). The first stage of the project involved identifying the challenges involved in implementing performance measurement systems in the construction industry and how to effectively make use of data collected in order to make continuous improvement in the sector (Andersen & Langlo 2016). This laid the foundation for the second part of the study, which involved selecting a specific performance measurement system to test in order to see how the tool worked in practice and to what degree the system lent itself to actually creating continuous improvement. CII's 10–10 system was chosen as the best possible candidate because of its likelihood of meeting the most requirements decided upon in the first stage of the study.

Data collection was based on projects that were input in the 10–10 database within Norway. At the time the analysis was carried out, a total of 45 projects had been entered into the database across 14 invited Norwegian companies (more companies and projects have been entered since). Individual files were extracted from the CII database containing the survey results for each of the Norwegian projects. The data were then entered into SPSS in order to generate descriptive statistics and run bivariate correlation analysis between input measures, output measures, project characteristics and key questions in the survey, in line with guidelines prescribed by Blumberg, Cooper and Schindler (2014). Because of the quantity of data and the large number of potential analysis angles, an initial discussion was conducted to narrow down the research to look at findings which would prove to be most valuable to the companies involved and management in charge of the project.

One limitation was the relatively low number of projects in the database at the time the study took place. This made it difficult to carry out statistically significant analysis between the phases as well as some of the individual survey questions or project characteristics, as they were only a part of certain phases. Furthermore, of the 45 projects entered into the database, not all of the surveys had a complete list of 10 output measures, making it also difficult to

analyse the usefulness of some of the output measures. A possible explanation could be that the project management team did not have the necessary data when they filled out the survey or that the measure was not applicable to that project. For example, even though survey data from 45 projects were pulled, only 36 of the projects had valid cost overrun estimates (as can be seen in table 1). As more projects are entered into the database, this limitation will naturally diminish.

Results and discussion

This chapter identifies some of the key findings from the analysis of the 10–10 data. It was important to see whether poor performance in the input measures resulted in decreased project performance, as gauged by the output measures, using actual project data from the 10–10 system. As previously discussed in chapter 1, the input measures comprised 10 indicators that were created from a series of 50 or so questions asked to project team members about various aspects of the project after five possible phases. These questions were characterized by their more subjective nature and looked at areas such as how the team members felt about the different relationships and experiences during the project. The input measures could therefore be considered as soft measures. Conversely, the output measures were based solely upon numerical metrics such as cost overrun or time delay and could be considered hard measures.

Comparing the input measures to select output measures, we found that 8 of the 10 input measures had significant negative correlations with the output measure of cost overrun. Namely, the planning, organizing, leading, controlling, design efficiency, human resources (HR), quality and supply chain input measures all could be used as indicators of cost overrun in the project. Conversely, the sustainability and safety measures had no significant relation with cost overrun. The results of the bivariate correlations between the input measures and cost overrun can be observed in table 1.

Table 1 Correlations between cost overrun and input measures

		Planning	Organizing	Leading	Controlling	Design Efficiency	HR	Quality	Sustainability	Supply Chain	Safety
Cost	Pearson Correlation	−0.575**	−0.590**	−0.569**	−0.485**	−0.412*	−0.597**	−0.565**	−0.131	−0.469**	−0.246
	Sig. (2-tailed)	0.000	0.000	0.000	0.003	0.013	0.000	0.000	0.446	0.004	0.148
	N	36	36	36	36	36	36	36	36	36	36
** Correlation is significant at the 0.01 level (2-tailed).											
* Correlation is significant at the 0.05 level (2-tailed).											

The findings in this case can be applied on an individual project level as well as on the overall industry level. On a project level, the results can be used to focus on aspects of the project, as outlined by the eight input measures, in order to reduce cost overrun. More precisely, if the project is already exhibiting high cost overrun in the early phases, it would be possible to use the survey questions that were mapped to the eight input measures to take corrective action to reduce, hopefully, such a cost overrun. Preventive measures could also be employed based on these relations.

On an industry level, the findings can be utilized to understand what the basis for cost overrun in a project is and what it is not in terms of the given input measures. In this sense, we

can see that cost overrun is not a fitting output measure in regards to safety or sustainability aspects, as the cause-and-effect relation is lacking, reflected by the non-significant correlations. If the industry wishes to make improvements in safety or sustainability, other outcome measures may be needed that are better suited to these areas, for example.

It was also quite valuable to look at what information could be gleaned from the individual survey questions that were used to create the input measures. A selection of the analysed survey questions is given below. Note that in this case all these survey questions came from the engineering/design phase, as that was where the majority of the inputted projects were from. Respondents could answer with a sliding-scale response of *Strongly Agree*, *Agree*, *Neutral*, *Disagree*, or *Strongly Disagree*, which were assigned integer values from 5 to 0 and then averaged over all the surveyed project team members who chose to answer the given survey question. The scores for the individual survey questions were then used as basis to compute the overall input measures scores.

Survey Question 16: The owner level of involvement was appropriate.

Survey Question 19: The project objectives and priorities were clearly defined.

Survey Question 26: The project team, including project manager(s), had skills and experiences with similar projects/processes.

Survey Question 27: People on this project worked effectively as a team.

Survey Question 28: The project experienced a minimum number of project management team personnel changes.

Survey Question 30: The interfaces between project stakeholders were well managed.

Survey Question 31: Key project team members understood the owner's goals and objectives of this project.

Survey Question 34: Leadership effectively communicated business objectives, priorities and project goals.

Survey Question 36: Project leaders were open to hearing "bad news," and they wanted input from project team members.

Survey Question 39: A high degree of trust, respect and transparency existed amongst companies working on this project.

Survey Question 46: The Design phase deliverables received from consulting engineers or other architects were complete and accurate.

Survey Question 48: A dedicated process was used to proactively manage change on this project.

Survey Question 52: The customer was satisfied with the Design phase deliverables.

It is evident that a wide range of areas are covered in these survey questions, ranging from customer satisfaction and stakeholder management to project team competence and the relationships between people working on the project. This is intended given that the 10–10 system is meant to function as a comprehensive performance measurement system, and a wide variety of issues need to be captured in these survey questions that make up the input measures. The results of a bivariate correlation between the survey questions and the individual input measures can be seen in table 2. The following scheme has been denoted:

Table 2 Correlations between survey questions and input measures

Survey Question	Planning	Organizing	Leading	Controlling	Design Efficiency	HR Resources	Quality	Sustain.	Supply Chain	Safety	Total
16-Owner involved	X	X	X	S	S	S	S		M	S	9
19-Objctve defined	X		X	M					M		4
26-Skill/ experience	S	X	S	X	S	X	S		S	S	9
27-Effective team	M	S	X	X	S	S	S			M	8
28-Team changes	S	X	X	X	S	X	S		M	M	9
30-Stkhldr manage	S	X	X	S	S	S	S		S	S	9
31-Owner understd	S	X	S	S	S	S	X			S	8
34-Effec. leaders	M	S	X	S	M					S	6
36-Open leaders	S	S	X	S	S	S	S		M	S	9
39-Project trust	S	S	X	S	S	S	S		X	S	9
46-Design delivery		M		X	X		X			M	5
48-Change process		S	S	X			M				4
52-Cust. satisfic.	S	S	S	X	S	S	S		S	S	9

- An **X** indicates a superfluous correlation as the question has been used in creating the respective input measure (note that all superfluous correlations were found to be positive and significant, with either moderate or strong strength).
- An **S** indicates a significant correlation with positive, strong strength.
- An **M** indicates a significant correlation with positive, moderate strength.
- An empty cell indicates no significant correlation.

It was interesting to see that many of the survey questions could be used as indicators of the scores for input measures that they had not been originally intended for, as observed by the non-superfluous significant correlations. This indicates that many of the questions have farther-reaching implications than even the system itself is predicting. Comparing these questions then to the output measures, we found that 7 of the 13 questions could then be used as key indicators when predicting cost overrun; namely, survey questions 16, 26, 28, 30, 36, 39 and 52. The results of the bivariate correlations between the survey question scores and cost overrun can be observed in table 3. All seven of the survey questions exhibited significant

Table 3 Correlations between cost overrun and survey questions

		Q16	Q19	Q26	Q27	Q28	Q30	Q31	Q34	Q36	Q39	Q46	Q48	Q52
Cost	Pearson Correlation	−0.583**	−0.146	−0.551*	−0.354	−0.463*	−0.602**	−0.360	−0.168	−0.503*	−0.520*	−0.094	−0.342	−0.765**
	Sig. (2-tailed)	0.007	0.540	0.012	0.125	0.040	0.005	0.119	0.479	0.024	0.019	0.772	0.140	0.000
	N	20	20	20	20	20	20	20	20	20	20	12	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

negative correlations with cost overrun. They were also the questions that had the highest number of significant correlations, both superfluous and non-superfluous, with the input measures, as can be seen by the shaded cells in the farthest right column of table 2.

Some of the results are expected, such as that customer satisfaction could be used as a forecaster of cost overrun given that it is a critical success criterion itself (Sanvido et al. 1992); or that the emotional intelligence of the project manager may play a significant role in project success (Rezvani et al. 2016). Although many of the survey questions deal with areas that would seem quite logically connected to project success, it is very valuable for organizations to see exactly what performance drivers are linked to what output measures based on empirical data. Through a mapping file provided by CII, it is possible for the organizations to see the exact questions that are used to form the basis for the input measure scores. Furthermore, it appears that many of the survey questions could have additional significant relations with other input measures not explicitly found in the mapping file. In this manner, it is possible for organizations to focus their efforts on key survey questions that are tied to many performance drivers, as well as to get a broad overview by viewing the aggregate benchmarked scores for both the input and output measure scores.

There is also potential to use the 10–10 system in order to understand more veiled obstacles. For example, perhaps an organization is weighing the worthiness of completing a life-cycle analysis for a project. Besides the obvious economic aspects, such as seeing whether there is an allocated budget for it or if there are contractual requirements to do it, there may be value in examining the 10–10 system for similar areas of overlap. Because of the extensive breadth of the 10–10 questionnaire and range of the input measures, quite a lot of aspects of projects are captured. In this case, the organization could examine various relations with the sustainability input measure in more detail by examining specific survey questions given that the organization has entered enough projects in the database to be able to conduct such analysis. In this case, one of the relevant questions is survey question 10 given below (Construction Industry Institute 2015).

Survey question 10: Was a life-cycle cost analysis completed for this project?

- *Yes*
- *No*

The results of the bivariate correlations between the input measures and survey question 10 responses can be observed in table 4.

Our analysis on an aggregate level reveals that, as expected, the *Yes* and *No* responses exhibit significant positive and negative correlations with the sustainability input measure, respectively, as the question was used to form the score for that measure given in the mapping file. Unexpectedly, however, we see that there is a significant negative correlation with the leading measure, and the *Yes* response, indicating that projects that completed a life-cycle cost analysis had lower scores in this measure than those that did not. A possible explanation could

Table 4 Correlations between survey question 10 responses and input measures

		Planning	Organizing	Leading	Controlling	Design Efficiency	HR	Quality	Sustainability	Supply Chain	Safety
Q10_Yes	Pearson Correlation	−0.259	−0.362	−0.442*	−0.404	−0.258	−0.223	−0.297	0.495*	−0.265	−0.112
	Sig. (2-tailed)	0.256	0.107	0.045	0.070	0.259	0.332	0.192	0.023	0.246	0.628
	N	21	21	21	21	21	21	21	21	21	21
Q10_No	Pearson Correlation	0.020	0.031	0.185	0.151	−0.017	0.182	0.144	−0.571**	0.090	−0.165
	Sig. (2-tailed)	0.931	0.893	0.422	0.515	0.940	0.430	0.532	0.007	0.698	0.475
	N	21	21	21	21	21	21	21	21	21	21
*. Correlation is significant at the 0.05 level (2-tailed).											
**. Correlation is significant at the 0.01 level (2-tailed).											

be that projects that needed to complete a life-cycle cost analysis required a larger number of stakeholders and thus had more conflicts among leadership. This type of information could be leveraged to implement additional conflict management training or to make sure roles and responsibilities are more clearly defined in the project team in the front-end phase when conducting a life-cycle cost analysis.

Variations as a result of project characteristics were also analysed. Differences were looked at in regards to areas such as project contract type, delivery method and nature, among others. Although no statistically significant findings were observed most likely due to the small sample size, the capability to see the difference in the output measures as a function of the characteristics is valuable in customizing action plans to fit different possible projects by anticipating the possible problem areas. For example, in table 5 the time delay between lump sum and cost plus contracts can be observed.

Table 5 Lump sum and cost plus contract time delay statistics

	N	Minimum	Maximum	Mean	Standard Deviation
Lump Sum	16	–0.66	0.12	–0.1095	0.20919
Cost Plus	9	–0.36	0.29	0.0184	0.16819

The results show that the projects utilizing a lump sum contract were on average 11% ahead of schedule, whereas those utilizing a cost plus contract were on average 2% behind schedule. The findings can be partially explained by incentives offered to the contractor. In lump sum contracts, for instance, there is a fixed payment contractors receive to complete the project, and thus it is to their benefit to finish as soon as possible to maximize their profit. In a cost plus contract, contractors may not have the same incentives to finish on time given that they are paid based on materials used and hours worked, which may explain the discrepancy between the two. If an organization therefore carries out a project using a cost plus over a lump sum contract, additional time buffers may be needed in schedule planning because of the greater likelihood of increased time delay in the project. It is important to note that an independent samples t-test gave a p-value of 0.131, indicating that these findings are not statistically significant. However, with a larger sample size we would expect that there would be a strong likelihood that the overall findings would still hold true.

These are just a few examples of how the 10–10 data can be effectively used by organizations. Based on a client's specific desires, a high degree of customization is available due to the breadth of the survey characteristics, which allows for analysis on multiple measurement levels. What is fundamentally quite valuable from the 10–10 system is that the exact areas of concern can be examined through the input measures or survey questions and the corresponding relations to the output measures, thus giving concrete areas for improving plans for a project. Furthermore, aggregate benchmarking statistics are also collected, which enable performance measurement at both organization and national/sector levels.

Conclusion

This study was an initial attempt to see how useful the 10–10 system is in practice, particularly for the Norwegian construction industry as the analysis was based exclusively on projects done in Norway. Additionally, access to the empirical data of multiple companies in the 10–10 system allowed for valuable insights and exploitation of project-level data for broader industry analysis. Some of the findings in this sense are relatively novel as such analysis has not been possible before due to the scarcity in acquiring such detailed aggregate data. The results show that the 10–10 system offers a high potential for improving project performance as well as conducting broader organizational and national analysis. A select few findings have been discussed in this paper that gives a brief glimpse into how the various aspects of the survey can be exploited for performance measurement improvement efforts.

Many key observations were discovered on the aggregate level that could be applied to individual project teams to help them perform better as well as assist management in taking corrective or preventive action in an effort to promote continuous improvement. Even though we were only able to find significant results concerning the cost overrun measure, this could be

attributed to the relatively small sample size and the possible variations between the measures from the phases or project areas. Also, because of the time constraints and large number of analysis angles, not all output measures were examined to the same degree, and some significant findings may have gone undiscovered.

One relatively new idea that has been introduced in this paper is utilizing the same system for project and organizational-level performance measures to examine broader industry trends. The value in this is that there is a clear connection between the levels of measurements built into the system. This is often contrary to many other systems that may focus on measuring on only one level, forcing organizations to utilize multiple measurement systems to meet the demands of all the stakeholders involved. In this manner, the 10–10 system circumvents needing to utilize such external productivity statistics as all projects entered into the database are used to create aggregate statistics for industry benchmarking.

Future research could include further analysing variations in input measures, output measures, survey questions and project characteristics that were not examined because of the lack of significance as a result of the small pool of projects in the database at the time the study took place. Potential areas include examining variations in project location, phase, type (infrastructure, industrial or building) and nature, among others. Additionally, if companies employing 10–10 used the system over a longer period of time and input a significant number of projects into the database, it would also be possible to undertake an analysis of the projects within the company itself. In this manner, significant cause-and-effect relationships could be identified unique to the company, providing a more tailored improvement plan.

As the 10–10 database expands to include more projects, the reliability and validity of the results will only increase. Without a doubt, additional significant findings will also be discovered that will prove invaluable for organizations employing the 10–10 system to more effectively monitor and improve project performance, as well as key policymakers to monitor the overall performance of the construction sector.

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CONFERENCE PAPER

Embracing emergence: problem solving on complex projects

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Synopsis

Managing within the unpredictable and complex environments of today's projects calls for new competencies to help interpret and respond to problems. Quantum storytelling can play a powerful role in reinterpreting project concepts such as *risks*, and their resulting *problems*, by harnessing the properties of emergence. The reframing of problems is explored through a complexity lens and underpinned by stories from the international development sector.

Research design

Actuality research, with its focus on the lived experience, provided the foundation for a research study exploring how project managers currently interpret problems on complex projects. Application of the storytelling diamond model supported methodology choice, and in-depth interviews were undertaken with six project managers from two organizations managing complex projects.

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Relevance for practice

We believe that developing an understanding of quantum storytelling and its potential application to managing projects has the capacity to assist project teams to make sense of the emergent nature of complex projects and to consider alternative approaches to solving problems.

Main Findings

The findings provide insight into how the project managers interviewed currently interpret problems and the resulting approaches to solving them. Their stories outline the themes that populate both the organizational and sectorial narrative of their projects.

We argue that traditional project methods apply control frames and behaviours through which to interpret concepts like problems, but in the real world, adaptable and flexible behaviours are required to tackle them as they evolve in the field. We determine that the traditional "plan and manage" contingency approach is not delivering to these project managers the competencies required to manage their projects.

Research implications

Our paper illustrates how a storytelling methodology can be used to explore problems and identifies the potential to further develop storytelling competency through adopting a complexity mindset with its inherent understanding of the property of emergence.

Keywords

Complex Projects, Problems, Storytelling, Complexity, Emergence

Introduction

This paper is a response to the increasing level of complexity of the 21st century. Caught in a nexus between extreme technological advancements and momentous social change (Schwab 2016), governments, businesses and individuals all feel a relentless sense of flux as we strive to solve the inherent complexity that plagues our projects (Hass 2009b; ICCPM 2012; Remington & Pollack 2007).

As we stare down the barrel of the Fourth Industrial Revolution, proposed to arrive in 2020, we are faced with a future described as, "in its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before" (Schwab 2016, p. 1).

In this age of hyper-connectivity we have networked our world and, in turn our problems, into a complex tangle of relationships, economies and societies (Dorst 2015). As business systems are becoming more networked and complex, the projects required to implement solutions to these, are correspondingly becoming more complex (Hass 2009a) and complex project management (CPM) is "emerging out of the dust of the persistence of failed, challenged, and costly projects" (Hass 2009b, p. 7).

This has led to a questioning of the applicability of project management approaches and methodologies that are founded on traditional control thinking to the complex environments in which today's projects are being managed (Cicmil et al. 2006; ICCPM 2012; Remington & Crawford 2004; Williams 2002).

The traditional project management (TPM) approach, based on a rational, linear perspective, views concepts such as "problems" and the pre-problem notion of "risks," as predictable events that can be planned for and managed. However in complex, and therefore unpredictable (ICCPM 2012), environments, we need new competencies based on emergence to interpret and respond to our problems.

In five years, over 35% of skills considered important for today's workforce will have changed, with "soft skills" populating the top 10 by 2020 (Gray 2016). The complex project management (CPM) competency standards, based on the CPM paradigm, which assumes uncertainty, change and emergence as the normative condition (ICCPM 2012), include *storytelling* as an essential skill for complex project managers (CPMs).

This paper applies a lens of complexity thinking, through the theoretical framework of *reframing through storytelling*, to explore how project managers make sense of problems. It illustrates how language, specifically the tool of storytelling, can play a powerful role in re-interpreting concepts like problems by harnessing the properties of emergence to view them in their emergent state.

Quantum storytelling, as coined by Boje (2008), is underpinned by a complexity mindset and interprets narrative as a living entity which has the ability to disrupt the dominant narratives of organizations, enabling a *re-storying* of our experiences into a new, anticipated version of the future. When quantum storytelling is applied to problems, viewing them in their emergent state provides a new lens to reinterpret them. This ability to reframe problems opens a door for CPMs to make sense of the dynamic, emergent and complex nature of the modern project and to consider alternative problem-solving approaches.

In this paper, stories from the international development sector (IDS) illuminate the results of a qualitative research study that used a narrative enquiry methodology and was based on in-depth interviews with six project managers from two organizations operating projects across international borders.

Actuality research (Cicmil et al. 2006), with its focus on *lived experience* and its base in complex social processes and project complexity, provided the foundation for the praxis study. The storytelling diamond model (Rosile et al. 2013) was used to select appropriate methodological approaches, and data analysis was undertaken using NVivo software.

The findings provide insight into how these project managers currently interpret problems and the themes that populate both the personal and sectoral narrative of their complex projects. These themes have been collated under the relevant dimensions of complexity as identified by Hass (Hass 2009a).

This paper aims to contribute to actuality research in projects through presentation of the lived experience of six experts managing complex projects in the IDS; to explore the overlap between the extant theories associated with quantum storytelling and the complexity mindset of CPM; to propose quantum storytelling as a powerful addition to the CPMs toolbox, with the potential to further develop the CPM competency standards; and to use storytelling as a valid research method on modern complex projects.

Background

THE ACTUALITY OF COMPLEX PROJECTS

There has been criticism of mainstream research into projects and project management in the past for its heavy reliance on the functionalist view of projects and organizations (Blomquist et al. 2010; Cicmil et al. 2006; de Bakker, Boonstra & Wortmann 2010). This control theory approach views project management as "the accomplishment of some finite piece of work in a specified period of time, within a certain budget, and to agreed specification (which is, in turn, a conventional definition of a project)" (Cicmil et al. 2006, p. 677).

However, proponents of project *actuality* reject the view of projects as pro-forma (Blomquist et al. 2010; Cicmil et al. 2006), instead believing them to be constituted by "the actions of interdependent actors through the process of power and conversational relating" and through engaging in sense-making processes (Cicmil et al. 2006, p. 677).

Actuality research represents a shift away from model-based theory towards praxis-based theory and research. It focuses on the empirical reality of project work, creating knowledge which is relevant to practice by exploring neglected themes from practitioners' experiences, including complexity, nonlinearity, values, multiple perspectives and social processes in project environments (Cicmil et al. 2006).

Actuality research was the foundation for this research to explore the *lived experience* of six project managers in the international development sector (IDS) or, expressed colloquially, "what is actually going on" in projects (Cicmil et al. 2006, p. 676).

FROM CONTROL TO COMPLEXITY

For this study, we used the following definition of a complex project from Remington (2011) that was particularly relevant to international development projects, given the focus on reputational risk rather than budget, "characterized by uncertainty and ambiguity . . . [and] designated as high risk . . . measured in terms of return on investment or reputation to the sponsoring organization" (Remington 2011, p. 3).

Through a complexity lens, we can view most modern projects as complex adaptive systems (CAS) rather than simple systems, due to their emergent nonlinear behaviour, adaptiveness and sensitivity to initial conditions (Remington & Pollack 2007). This requires a paradigm shift away from thinking of projects through a traditional control theory perspective (Hass 2009).

If we view projects as CAS, then management approaches are required that are based on a complexity mindset (ICCPM 2012) and are "different, more flexible, responsive, adaptive and . . . richly communicative" (Remington 2011, p. 4), enabling development of a bespoke mix of theories and tools, drawing insight from a wide range of sources not historically part of the project manager's toolbox (Pollack 2009; Remington & Pollack 2007).

The Complex Project Manager Competency standards are a relatively recent development (latest version 4.1 released in 2012) defining the paradigm, behaviours and body of knowledge required to operate effectively within complex project environments (ICCPM 2012, p. 2). Traditionally "soft skills," including personality traits and attitudes, had not received adequate attention in the project management literature (Creasy & Anantatmula 2013; Hyväri 2006; Skulmoski & Hartman 2009); however, the CPM standards now include storytelling in: View 7, Leadership & Communication; Element 7.6, Communication; Actions in the workplace, 7.6.3:

> *Uses storytelling to create a positive and engaging environment for staff and external stakeholders.*

The prerequisite knowledge required for this competency includes 7E Communication Frameworks:

> *Language strategies and shared meaning; (and the) Impact of language strategies and storytelling (CCPM 2012, p. 77–9).*

We make an important distinction in this paper, introducing the notion of quantum storytelling (Boje 2008), which is the transformation of storytelling from knowledge (epistemology) and empiricism (methodology) to one of being-becoming (ontology) (Rosile et al. 2013). Based on a complexity mindset, this modern form of storytelling embraces the properties of emergence and thereby has the potential to further develop the standards.

FRAMING PROBLEMS

Traditional project management approaches concepts such as problems, or issues, through a conventional control theory perspective as events to be planned for and managed (Taylor & Watling 1970).

The entire premise of this conventional thinking is the assumption these are predictable events that can be planned for using strategies and tools based on a linear view of past experience. In practice, it's the unforeseen problems that plague projects; we can't plan for the actuality of problems – only for their likelihood. We can't predict when they will emerge within the project life cycle or how they will unfold within the context of the complex project environment.

Project managers currently define problems through a control frame in their various states of being – in prospect, to be identified as "risks" and in their eventuality, to be registered as "issues." However, complexity thinking offers a new way to view problems, enabling them to be reconceptualized, or reframed, as an events emerging from changes to the system.

Framing is not a new idea; Aristotle wrote about frames (Boje 2008). Simplistically, a frame is a point of view or an idea that can be used as a metaphor to enable another way of seeing. Reframing had its origins in the design industries and more recently has been attributed to the Design Thinking discipline as a core skill for managerial problem solving (Brown 2009; Liedtka et al. 2013).

This ability to *reframe* provides a novel and potentially powerful approach to developing solutions in praxis that take into account the complex and emergent nature of modern projects.

REFRAMING THROUGH STORIES

Language is the tool we employ to create meaning and therefore to define the frames through which to view our life experiences.

According to Snowden (2012) stories are the fundamental patterning device through which *human complex systems* understand the world. Because of higher levels of intentionality, unpredictability and intellect, we are very different from nature's systems, and therefore we do things that aren't logical in terms of simple system rules and agent-based behaviour (Snowden 2012).

Our world views are socially constructed. The historical, societal and familial narratives we are born into help shape our identities and provide meaningful *cognitive frames* for interpreting

reality (Milojević & Inayatullah 2015). For us, "the stories we grew up with control the way we think" (Snowden 2012).

Most people believe that they are perfectly rational agents with views based on an accurate reflection of an objective reality. However, our world views are constructed of dominant frameworks of meaning, or *dominant narratives*, based on our past and legitimized and perpetuated by the people around us, political or economic structures, and tools such as mass media (Milojevic & Inayatullah 2015). The way that we interpret our experiences, and the personal narratives we hear and deliver, depend on the collective world view that legitimizes them.

Therefore *storying*, the ongoing process of constructing and reconstructing reality through stories, ultimately determines our decision-making (Milojevic & Inayatullah 2015).

Organizational Storytelling for Control

Storytelling has been called the sense-making currency of organizations playing a crucial role in creating and sustaining organizational identity (Rosile et al. 2013). Every organization, workplace, school, government office or local religious group can be seen as a *storytelling organization* (STO) (Boje 1991), as we understand human conduct through our intentions and understand our intentions through the settings that give them context (MacIntyre 1981, 1990; Schütz 1973, as cited in Czarniawska 2004).

In his 1995 seminal work on the theory of narrative sense-making, Weick focused on the retrospective action of storying current experience to fit into past meaning, for the purpose of narrative control and coherence within organizations. According to Weick, retrospective stories transmit and reinforce third-order controls (assumptions and definitions that are taken as given) by conveying shared values and meaning. This retrospective view controls sense-making by filtering desired information in the present and retro-fitting it into a linear and coherent beginning, middle, end (BME) narrative structure in the past (Boje 2008).

The BME perspective is fundamental to the history of storytelling, immortalized by Aristotle and validated by the early work of Czarniawska: "For (stories) to become a narrative, they require a plot . . . to bring them into a meaningful whole" (Czarniawska 1998, p. 2). The BME plot is the overarching structure that underpins the dominant narratives of organizations today and the basis of narrative control (Boje 2008).

Boje (2008), one of the formative authors on storytelling and narrative theory in organizational research, extends Weick's notion that story is imprisoned within the dominant narrative. Over the course of modernity, *narrative* has become a centring force of control and order in organizations, aspiring to abstraction and generality. The counter-force to that is *living story*, which has retained a more grounded interplay and connection with the life world and is a destabilizing force of diversity and disorder (Boje 2008).

LIVING STORY: THE ANTICIPATED FUTURE

Living stories are polyphonic and dialogic (Bakhtin 1973; 1981, as cited in Boje 1995, 2008), situated in place, in time and in the material processes of the collective voices within an organization (Rosile et al. 2013).

Living story is the key to interpreting narrative as a living entity itself, an unpredictable, emergent and collective action that is being re-narrated, reinterpreted and re-storied simultaneously, textually, orally and visually throughout the organization in real time (Boje 2008). Through the living story, it is possible to re-story the past dominant, or grand, narrative

(Lyotard & Van Den Abbeele 1984) into a new story of the anticipated future. This represents a new type of "prospective" sense-making (Boje 2008).

The driving agent in this prospective and emerging future is the *antenarrative*, the dynamic processes at work between the narrative paradigms. The antenarrative, a "non-linear, incoherent, collective, unplotted, and pre-narrative speculation" (Boje 2001, p. 1), is essentially story in evolution, a forward-looking bet, or ante-story, that a proper story will emerge.

The antenarrative can be viewed as *emergence* in the narrative sphere, and like the infamous butterfly of complexity theory, it has the capacity to change the future, to set in motion transformations that can impact the big picture, realizing a potential future that otherwise would not exist.

Research methodology

The aim of this research was to explore lived experience or empirical reality of projects as outlined in actuality research (Cicmil et al. 2006) in order to provide insight into how project managers make sense of, and respond to, problems within the dominant narrative framework.

Key to actuality research is a focus on the social processes, such as "conversational relating," in project environments (Cicmil et al. 2006). Therefore, a qualitative research approach was adopted using the narrative enquiry methodology, and six in-depth oral history interviews were conducted to collect stories about the management of IDS projects.

APPLICATION OF THE STORYTELLING DIAMOND MODEL

The results of a study, have the potential to vary dramatically depending on the researcher's paradigmatic perspective (Diefenbach 2009; Pratt 2008), in particular a qualitative storytelling study (Rosile et al. 2013).

Rosile et al. (2013) developed the *storytelling diamond model* (figure 1) from the history of storytelling. The typology assists researchers to select a methodology appropriate to the research goals by matching ontological and epistemological assumptions. These paradigmatic choices are summarized in the storytelling diamond model (figure 1) and outlined in table A.

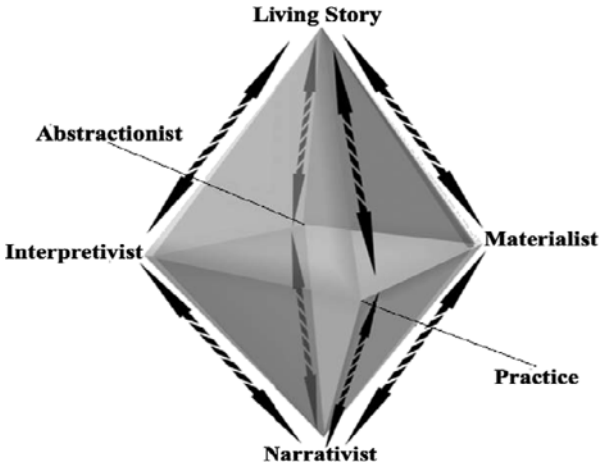

Figure 1 Storytelling diamond model (Rosile et al. 2013, p. 559) with arrows showing the antenarrative processes

To situate the study, the model was applied and the *living story paradigm* identified as the best paradigmatic fit, due to the focus in the literature on complexity thinking and emergent forms of narrative. An "ethnographic and emic" approach was also recommended.

One advantage of storytelling enquiry is that it is useful at both the theoretical and applied levels (Rosile et al. 2013). From a theoretical perspective, stories can be collected, analysed and categorized to gain a picture of interpretation and meaning. In terms of practice, it is a rich method of studying the actuality of processes, material conditions and identity in the field (Rosile et al. 2013).

Table A Organizational paradigm choices for researchers (Rosile et al. 2013, p. 566)

Organization Storytelling Paradigms:	Epistemology	Ontology		Method
If participation will destroy the phenomenon, then use the deductive grounded theory of the **narrativist paradigm.**	Search for poetic, linguistic, formalistic, structuralist themes, schemata, underlying essentialist patterns	N/A		Fieldwork, etic grounded theory building, archival comparative cases to explore or extant theory; can be quantitative narrative studies
If a process understanding of the phenomenon is required, then use the living story paradigm.	**N/A**	**Process focus on patterns of story relating intertextually to other stories**		**Ethnographic emic approach, may integrate other artifacts; some poststructuralist approaches**
If using either a subjective internalized history or sociological historical focus, then use a **materialist paradigm.**	Cognitive materialism	Material storytelling and quantum storytelling	How materiality tells stories	Study relation of storytelling to material conditions and superstructures; neuroscience; critical posthumanism
If developing representations of an organization, then use **interpretivist paradigm**.	In representationalism, the part represents the whole	In historical materialism, it is a search for idealogical dialectics		Often positive hermeneutics, historical, or negative (critical) hermeneutics
If in need of abstract categories for use in future generalized research, then use the **abstractionist paradigm**.	Abstracting to the universalist or transcendent level of knowing	N/A		Can be quantitative data mining of semiotic patterns, or qualitative coding of types, forms
If endeavoring to change ideological practice, or change or develop processes of action, then use a **practice paradigm**.	Storytelling as in-place metering device of change/development or ideological praxis	Storytelling as part of restorying and ontological coaching		Many types of method: from survey checklists of storytelling, to ethnography, participative observation
If tracing the in-betweenness of narrativist and living story, how one affects or interacts with the other, then use **antenarrativist process.**	Works in between epistemology and ontology			Works in between quantitative and qualitative

RESEARCH DESIGN, DATA COLLECTION AND ANALYSIS

In-depth interviews were conducted with six project managers from two organizations based in Europe that operate complex projects within the international development sector (IDS), which was chosen with the assumption that it would provide a connecting storyworld across international borders.

Participants selected one project as the subject of their interview. Selection criteria for projects were that they must be complex (as defined by Remington & Pollack 2007); have encountered a *significant problem that threatened the project success criteria* (as defined by the project team); and have been managed by one project delivery team (for consistency of data).

Interview questions were based on concepts from the literature, designed to be asked in any order, allowing the interviewer to follow the specific trajectory of the participant's story, to explore the emergent themes.

The first question asked participants to *tell a story* of the most *significant problem* they encountered on one of their chosen projects, which aimed to define both the chosen project and a key problem encountered on that project as focus for the interview.

Interviews were recorded and transcribed, and narrative thematic analysis supported by use of the qualitative data analysis software NVIVO (*NVivo for Windows: NVivo qualitative data analysis software version 11* 2015).

Thematic analysis focuses on themes that develop across stories, across a data set in order to find repeated patterns of meaning (Braun & Clarke 2006, as cited in Liamputtong 2013).

A coding device has been used in the results to preserve anonymity: participants are coded with names of philosophers and the organizations with the names of philosophy schools as shown in table B.

Table B Participant, organization and project details

Participant	Project Type	Org.	Role	Country of Project	Project Type
1. Epicurus	Antiquity School	1	Project Manager	Bangladesh	Social Protection Reform
2. Seneca	Antiquity School	1	Project Director	Bangladesh	Social Protection Reform
3. Socrates	Antiquity School	1	Project Manager	Uganda	Social Protection
4. Descartes	Modern School	2	Project Junior	Philippines	Technical assistance
5. Kant	Modern School	2	Project Manager	Philippines	Technical assistance
6. Sartre	Modern School	2	Project Manager	Africa	Infrastructure, transport, energy & climate change

From themes to *Storyworlds*

Herman (2004, as cited in Squire et al. 2014) coined the term *storyworlds*, which grow around events or specific phenomena and are comprised of collections of different types of intersecting, linked narratives that cross historical time and social situations.

Thematic analysis focuses on themes that develop across stories, across a data set (Riessman 2008, in Squire et al. 2014), and these merge to form storyworlds. In this study, we identified the storyworlds occurring in the macro environment external to the IDS projects, which included global, regional, sectoral and organizational issues.

Findings

COMPLEXITY DIMENSIONS

The findings illustrate how the participants currently interpret the concept of "problems" and approach problem solving on their complex IDS projects. The results have been structured using the emergent themes from the data, with those themes collated under the relevant dimensions of complexity identified by Hass in the *Project Complexity Model* 2.0 (Hass 2009a) (Appendix 1).

There are various approaches to defining the dimensions (Baccarini 1996; Gransberg et al. 2013; Hass 2009a; Remington & Pollack 2007; Williams 2002) developed to identify the nature, or source, of the complexity (Remington et al. 2009). This model assists CPMs to diagnose the complexity profile of a project, and in line with this, what level of project leadership (competencies) is needed, and therefore what problem-solving approaches are required, to manage those specific dimensions (Hass 2009a).

Three of the Complexity Dimensions (no. 3, 4, 6) manifested in the context of the themes emerging from the IDP project data. The following themes related to dimension no. 6 (table C):

Table C Project complexity model 2.0 (Hass 2009, p. 9), dimension no. 6

Complexity Dimensions	Project Profile			
No. 6	Low Complexity	Moderately Complex	Highly Complex	Highly Complex Program 'Megaproject'
Strategic Importance, Political Implications, Stakeholders	**Executive Support:** strong **Political Implications:** none **Communications:** straightforward **Stakeholder Management:** straightforward	**Executive Support:** adequate **Political Implications:** minor **Communications:** challenging **Stakeholder Management:** 2–3 stakeholder groups	**Executive Support:** inadequate **Political Implications:** major, impacts core mission **Communications:** complex **Stakeholder Management:** multiple stakeholder groups with conflicting expectations; visible at high levels of the organization	**Executive Support:** unknown **Political Implications:** impacts core mission of multiple programs, organizations, states, countries; success critical for competitive or physical survival **Communications:** arduous **Stakeholder Management:** multiple organizations, states, countries, regulatory groups; visible at high internal and external levels

The storyworld of international development projects

The storyworld represents the common themes arising from the stories the participants told about their projects within the international development sector. Here the word cloud (figure 2) illustrates graphically the prominent themes of *working, impact, governments, project, change, people, funding, political*.

Figure 2 Word cloud of storyworld issues

The issues identified as most relevant by each organization were as follows (figure 3):

- Organization 1 (Antiquity School): sustainability, reputation and fiduciary risks were discussed most, with natural disasters, political situation and security threats also referenced.
- Organization 2 (Modern School): primarily political issues, with some references to the availability of local expertise and levels of government commitment.

Of the key issues identified, the participants discussed most the impact that the political situation had on their projects. It's worth noting that there were a broad range of issues which were attributed to this topic, including elections, political instability and challenges of working with parties across the political spectrum.

> This would justify an entire essay; however, in essence, a lot of our projects are donor funded, with donors (often government related) being under tremendous pressure to justify foreign aid, particularly towards the end of a voting cycle. This, in fact, applies to both donors as well as host countries, where projects are also tied to the government. The outcome is that projects are expected to show immediate results, which, depending on the business case and design of the programme, is not always feasible.

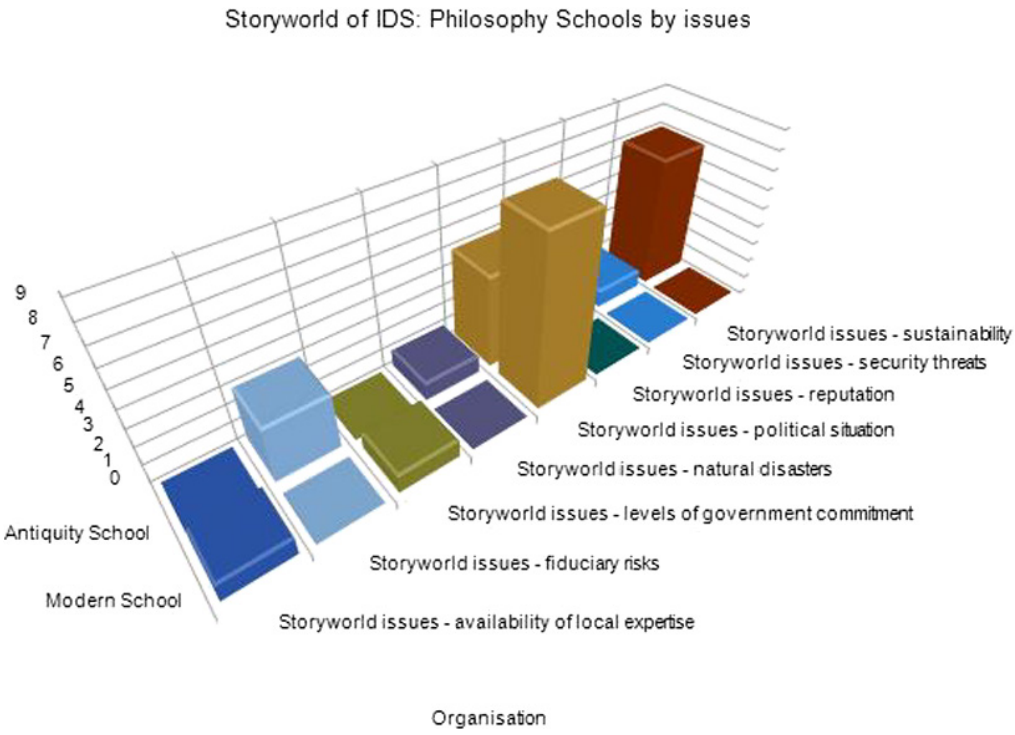

Figure 3 Chart of storyworld issues

Sustainability of their efforts was another preoccupation, to ensure that their projects created long-term change to the benefit of the populations in the host country, which is a core KPI for development projects. The type of project being managed had an impact on which issues were discussed, again with the political situation being the key topic and having the biggest impact across all projects.

> There had been presidential elections in [country name]. The chosen candidate is close to extreme left-wing positions, and he is quite a change compared to the current situation. This will dramatically affect our project, even if it is quite technical. Our counterparts in most of the government agencies will be changed, and the pace of implementation will get reduced considerably.

Project complexity

Participants described their projects as complex for these reasons:

- The contract.
- A large number of stakeholders.
- The methodology.
- The political environment.

Of the six participants, only one participant in Organization 2 defined the project (Infrastructure, transport, energy & climate change) as *not complex* because *it was able to be controlled*. The project types that were defined as complex were Social Protection, Social Protection Reform and Technical assistance (figure 4). The most discussed reason for complexity on projects across both organizations was *a large number of stakeholders*.

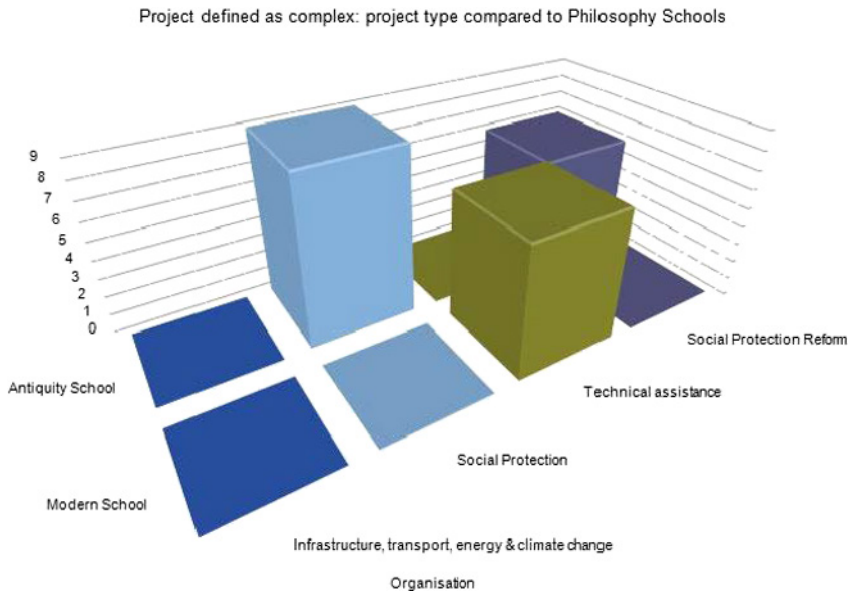

Figure 4 Chart of project defined as complex

> Development is always a complex relationship because you've got multiple clients. You've got the client who's providing the funding being the donor, and then you've got the client who is the recipient, which is the government of (country name), in this case, the Ministry. They often have very diverging points of view.
>
> It is very complex in the sense that we have to deal with a very large number of government stakeholders that do not necessarily always have the same agenda. To give you a specific example, we mainly deal with the Ministry of Finance, which is a very strong ministry within the government, and we also deal with six other line ministries.
>
> For me, the thing that makes it very complex is that we have too many counterparts in the government.

THE STORY OF THE PROBLEM

Participants were asked to identify one significant problem on their project and to tell the story of that problem. The emerging themes are illustrated in the word cloud (figure 5): *government, project, experts, contract, problem, senior, work, provider, people, change*.

Type of Problem

From the participants' stories, only three core problem types were identified:

- Financial.
- Human resources.
- Levels of government commitment.

Government commitment levels were the most discussed problem across the two organizations.

Figure 5 Word cloud for the story of the problem

> This is a common problem in all these kind of projects where you have to deal with government officials. And, in fact, you are not working in Norway or Sweden; you are working in a kind of emerging economies with different ways of doing things. So the problem is that you are dealing with officials [and] one, that have their own interest, [and] two, that changes quite quickly. You have one person in charge that perhaps lasts only one year in his position, and each time that they have elections, your project gets paralyzed three months before and six months after because . . . when they have elections, they change everybody, even the lady that makes the coffee.

Both organizations identified contracts and levels of government commitment as problems, with Organization 2 also experiencing human resources problems.

> The main problem we faced at the beginning of the project was that the contract – there should be the contract between us as a service provider and the client – was signed before the client had sufficiently negotiated with the in-country government. So basically, we did not have a memorandum of understanding. There was what is called a [type of project agreement] which was not signed. So basically we were hired, yet we didn't have any mandate to really operate incountry.

The type of project that the participants were managing influenced the type of problem discussed (figure 6):

- The Social Protection Reform project experienced issues mainly with levels of government commitment and contracting.
- The Technical assistance project experienced an even spread of the three issues identified.
- The Social Protection project experienced mainly contracting issues.
- The Infrastructure, Transport, Energy & Climate change project experienced mainly human resources issues.

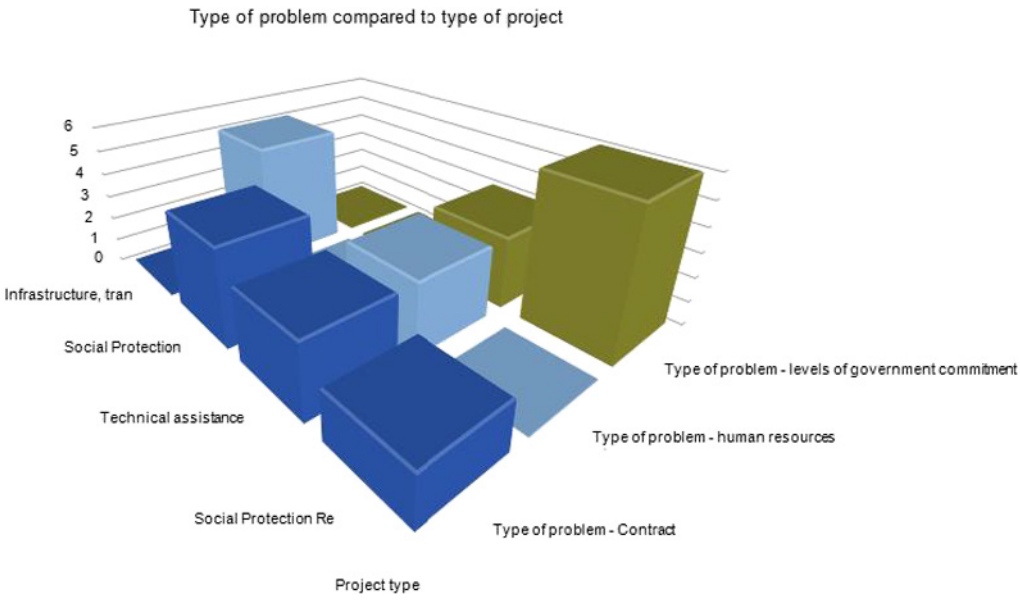

Figure 6 Chart of type of problem

Reason to solve the problem

The participants identified four main reasons why the identified *significant problem* on their projects had to be solved:

- Financial.
- It would kill the project/the project would be cancelled.
- Operational, related to the long-term sustainability of the project.
- Reputation of the project or sponsor organization.

Reasons to solve the problem were very similar for both the organizations, with Organization 1 also concerned about operational issues as related to long-term sustainability. Reputation and financial reasons were the most discussed reasons during the interviews.

> The pressure was basically on us. It was quite simple: we either solve this problem and get a [name of type of agreement], or we would not have a mandate to operate in country or the project would be closed.

> So the problem was that maybe he has to leave the project and he has to leave the country, and we would have to look for someone to replace him, and we wouldn't find him, and so we will have to cancel the contract.

> From a corporate perspective, it's obviously a big risk, a reputational risk as well as financial, and you don't want to start a project and then not be able to assist the client in negotiating this [name of type of agreement; and have the project canned, which wouldn't look very good.

The type of project that the participants were managing influenced the reason to solve the problem (figure 7):

- The reason that *It would kill the project* was the most consistent reason across all types of projects.
- However, for the Technical assistance project, *reputation* and *financial* risks were mainly discussed.

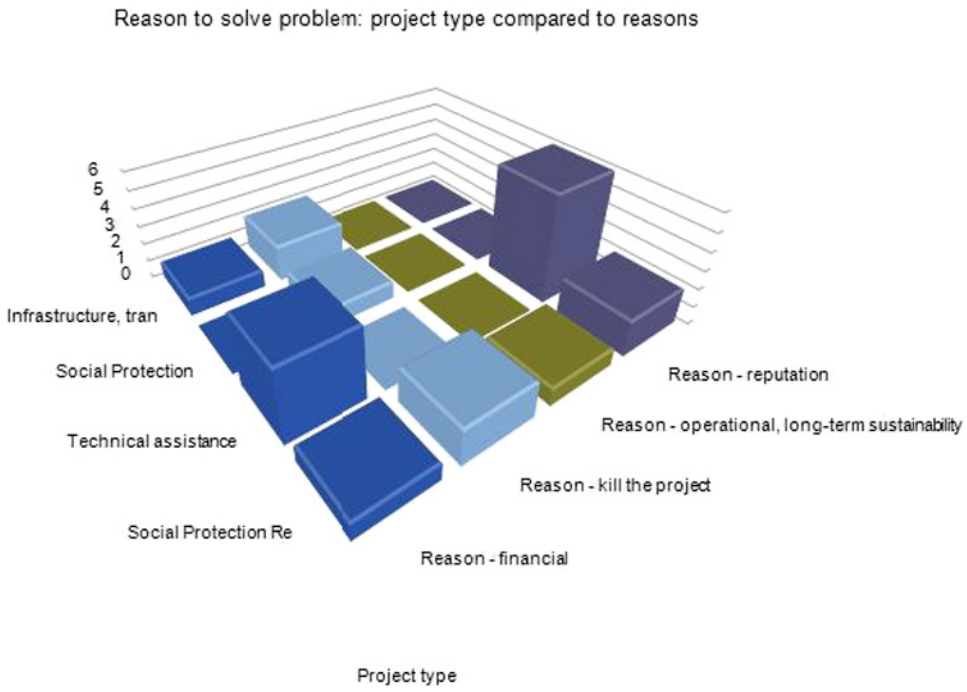

Figure 7 Chart of reason to solve the problem

The results for *Why solve the problem?* can also be attributed to Complexity Dimension no. 8 (refer to the model in Appendix 2), as the reason that *It would kill the project* represents a very high risk.

Bureaucracy, power and corruption

The interviews raised issues linked to the notions of bureaucracy, power and corruption:

> The only real way you can prepare for [corruption] is by ensuring you have robust systems in place. It is interesting because [donor name]'s take on social protection is that you can never eliminate [corruption], but they expect us to have a zero-tolerance approach, which is paradoxical in a way.

> He was called Commissioner [name], and he was one of the most corrupt people I've ever met. Even he is the cousin or the brother or so on of many of the owners of the companies working in the ports. So [he] has not the slightest intention of applying any [donor] regulations there at the Customs . . .

The following themes related to dimension no. 4 (table D):

Problem-solving approaches

The participants identified only two core approaches to problem solving on their respective projects:

- Project planning: prevention, mitigation approaches.
- Problem solving: in-field, practice-based approaches.

The responses were mixed among the organizations, with both developing and applying prevention strategies during project planning and then, once the problems were identified, applying "in-field" responses to solve them.

Table D Project complexity model 2.0 (Hass 2009, p. 8), dimension no. 4

Complexity Dimensions	Project Profile			
No. 4	Low Complexity	Moderately Complex	Highly Complex	Highly Complex Program "Megaproject"
Clarity of Problem, Opportunity, Solution	**Objectives:** defined and clear **Opportunity/ Solution:** easily understood	**Objectives:** defined, unclear **Opportunity/ Solution:** partially understood	**Objectives:** defined, ambiguous **Opportunity/ Solution:** ambiguous	**Objectives:** undefined, uncertain **Opportunity/ Solution:** undefined, groundbreaking, unprecedented

None of the participants applied a particular theory-based problem-solving methodology to their projects.

> It very much is just a practical approach. What do we know has worked in the past? What are the options? . . . we don't apply a specific methodology to problem analysis because we've got problems every day. We've got issues every day and some of them are bigger than others and it's really about experience, understanding who are the different parties, who have concerns with this, what is their perspective, what's our perspective, what's our bottom line, what do we need to achieve . . .

A majority of the participants focused their discussion on the prevalence of in-field, practice-based approaches, believing that because of the uniqueness of their projects, and therefore project-related problems, standardized problem-solving approaches were not effective, and solutions had to be developed based on the project managers' knowledge or by asking colleagues.

> It's a mixture of having systems in place and using the project manager's or project director's experience on how we handled similar problems on other projects or in the past, and then to just come up with a solution; and a lot of times, by definition, that is reactive to some extent. You can use some tools, but it will have to be a tailored approach. I don't think a one-size-fits-all approach would be any good to address very specific problems.

> I mean solving that problem, yes, it has a way. You have a procedure to follow but solving other types of problems – political ones, poor implementation, relationship with the [donor name], with the task managers – it's much more experience-based. So you have to know the country.

The word cloud (figure 8) illustrates the commonalities in the problem-solving approaches discussed: problem, project, work, managers, experience, experts, trying, solve, approach, situations, people, strategies.

Figure 8 Word cloud for problem-solving approaches

Role of the PM in problem solving

When asked to provide a *metaphor or description* for being a project manager (no category prompts provided), the participants identified with three general ideas:

- A firefighter.
- A good communicator.
- A tolerant and adaptive person.

Notably, four of the six project managers provided the metaphor of a *firefighter* – three from Organization 1 and the fourth from Organization 2. Communications, tolerance and an adaptive personality were other descriptions provided. The choice of *firefighter* as a description is linked to the reactive nature of the role to problems.

> Well I think we're like firefighters, yes. We get the call when there is a problem usually. And when we do, it's very urgent, and there are a lot of things at stake.

> Well, the first thing that comes to mind is definitely the firefighter . . . the firefighter has a team which needs to be co-ordinated, and obviously you have training and you have a plan; you have your fleet; you probably know which fire station responds to which problem. So there's a bit of planning, yet you don't know where the fire is going to be. So similar to a project . . . there are some systems in place. They are more generic . . . they can't detail about every single problem.

> The image this brings to mind is firefighter. Well, I think it's a case that you try and have a well-developed and prepared plan going forward, and then something suddenly comes out of the blue, totally unexpected, and because you've got to react extremely quickly to resolve the issue.

The following themes related to dimension no. 3 (table E):

Table E Project complexity model 2.0 (Hass 2009, p. 8), dimension no. 3

Complexity Dimensions	Project Profile			
No. 3	Low Complexity	Moderately Complex	Highly Complex	Highly Complex Program "Megaproject"
Urgency and Flexibility of Cost, Time, and Scope	**Scope**: minimized **Milestones**: small **Schedule/ Budget**: flexible	**Scope**: achievable **Milestones**: achievable **Schedule/ Budget**: minor variations	**Scope**: over-ambitious **Milestones**: over-ambitious, firm **Schedule/ Budget**: inflexible	**Scope**: aggressive **Milestones**: aggressive, urgent **Schedule/ Budget**: aggressive

Project time frame

Participants had two distinct opinions with regard to the project time frame, that it was achievable, but that they had to undertake an extra workload; or it was too short to achieve the stated objectives. Of the four which discussed the project time frame, only one from Organization 2 believed it was achievable; the others were either seeking an extension from the project sponsor or adjusting the outputs and/or expending budget on additional resources to meet the contracted deadlines.

> They're looking at an extension but, essentially till [date], which, in terms of reforming a social protection systems, is an awfully short time.

> I am trying to get a joint solution for both problems . . . because what I want is the [donor] to give me an extension of the implementation period. For example, they would say you can get an extension of 10, 12 months, and I would accept that extension, which is not very good for me because it does not imply a budget extension.

> The project is still going on . . . but we're trying to extend the project by either one year or two years, last but not least because of the delay. The project I'm talking about is basically policy reform; it's capacity building within the government. The other issue is that, including all the different phases, the project was only 32 months long, and that's very, very short for such a complex government restructuring/policy reform project. If you look at comparable projects, it usually takes a long time for governments to change.

Discussion

Discussion here focuses on relating findings to theory as presented by the themes discussed in the literature review, and on implications for practice.

STORYTELLING: A RESEARCH METHODOLOGY FOR COMPLEX PROJECTS

This paper illustrates how a storytelling methodology can be used to explore problems on complex IDS projects. The collected stories delivered data providing insights which

contributed to a better understanding of the interpretation of problems by the CPMs, and the resulting approaches chosen to problem solving.

The methodology enabled exploration of the lived experience *(*actuality research) of the six project managers directly: through their stories we hear their voices. The application of the storytelling diamond model provided rigour to the study through a systematic and detailed (Rosile et al. 2013) approach. It situated the study by identifying the researcher's potential bias through sympathies with the Living Story paradigm. It also provided direction to use an "ethnographic and emic" research method.

However, given the power of language to frame our experiences, collecting stories of past events is a methodological challenge in narrative research. Humans naturally reframe our experiences to retrofit a BME perspective (Boje 2008) reflecting the dominant narratives that pervade our lives – our organizations, upbringing and our collective experiences. Although the participants in the study discussed problems in the past tense, forms of "living story" capture have been documented by researchers (Boje 1991, 1995, 2001; Snowden 2012), and the in-field processes of actuality research lend itself to this type of research.

> Researchers . . . looking at ways of extending organizational inquiry through more expansive narrative might be interested in quantum storytelling and the role that living story plays in it . . . (with its) potential to open a new door into interpreting narrative not as a coherent, linear account of events but as a living entity itself. (Rosile et al. 2013)

The organizations studied are *storytelling organizations*, collective storytelling systems caught between the self-organizing forces of narrative control and story diffusion (Boje 2008). An understanding of this, and related concepts such as emergence, reframing and emergent story (living story, antenarrative) (Boje 2008), could provide the CPMs with a new frame through which to view their complex IDPs.

STORYWORLD OF THE INTERNATIONAL DEVELOPMENT SECTOR

The data themes provided insights into both the personal and sectoral concerns of the participants, and these illustrate *storyworld* of the *issues related to the IDS*. Storyworlds (Herman 2004, as cited in Squire et al. 2014) identify past events that have been experienced individually and collectively, creating an awareness of phenomena to be managed.

Eight key current issues that impact their projects were identified by both organizations, with the *political situation*, for example the impact of government elections and concerns for *sustainability* and long-term change, the most discussed.

Across the two organizations, the participants identified three core problem types, showing a consistency of problems across the IDS. *Level of government commitment* was the most discussed, in many cases tied to discussion on the influence of bureaucracy, power and corruption.

The participants were all concerned about the project time frame, either seeking an extension or adjusting the outputs and/or expending budget on additional resources to meet the contracted deadlines.

By identifying these issues on global, regional, and sectoral levels (external to organization) or on a project level (internal), the organizations can apply these learnings to decision-making, for example contract negotiations or strategy development for future projects.

A majority of the themes emerging form the data manifested within Complexity Dimension no. 6, which focuses on the issues of strategic importance to the organization, political implications, communications and stakeholder management. One of the almost universal challenges to complex projects is a high number of stakeholders and the complex interactions between them. These issues of "conversational relating" (Cicmil et al. 2006) require a strong competency in leadership to harness the power of storytelling to engage, motivate and create shared meaning amongst stakeholders (ICCPM 2012).

INTERPRETING PROBLEMS ON COMPLEX PROJECTS

The literature explores the idea that traditional project management methods apply a control frame through which to interpret concepts like "problems" and "issues", however, the findings show that in the real world, adaptable, flexible behaviours are needed to tackle problems as they emerge and evolve in the field.

The *firefighter* metaphor was the most popular description for what it was like to be a project manager for both organizations, which can be directly related to the reactive nature of their role relative to the problems. The participants believed that if they didn't solve the problem, it would risk the organization's or sponsor's reputation, the financial outcome of the project or – worse –the project would be cancelled.

Across the two organizations, approaches to problem solving were logically divided between *planning* (prevention/mitigation) and *problem solving* (the action following problem identification). None of the participants mentioned or applied extant theoretical problem-solving methodologies to their projects, and all focused their discussion on the prevalence of in-field, practice-based approaches. It was a common belief that, because of the uniqueness of their projects, standardized problem solving approaches were not effective, and solutions had to be developed in situ and based on experience.

Therefore the "plan and manage" contingency approach is not delivering to the IDS project managers the required competencies to manage their complex projects.

Quantum storytelling, through the living story, with its ability to reframe problems by harnessing emergence to view them in their emergent state, opens the door for CPMs to consider alternative approaches to solving the result.

QUANTUM STORYTELLING: PART OF A CPMS TOOLBOX?

This paper explores the overlap between the extant theories associated with quantum storytelling and the complexity mindset of CPM, proposing quantum storytelling as a powerful addition to the CPMs toolbox, with the potential to further develop the CPM competency standards.

Of the four projects discussed in the study, only one project was defined as *not complex* because it was *able to be controlled.* The complexity of the IDS projects was attributed to *a large number of stakeholders*, mainly government donors and clients.

The participants used their practical experience and knowledge of the context to define their projects as complex, rather than applying theoretical methodologies (even if praxis based). The themes emerging from the data were able to be categorized under three of the complexity dimensions; therefore, for these CPMs in the IDS there is an opportunity to improve diagnosis of the complexity profile of projects before making management decisions (Hass 2009a).

Knowledge and training in the CPM competencies would assist them to determine what level of project leadership is needed, which project cycle to use and how to manage the complexity dimensions identified on their projects (Hass 2009a). Methodological tools and competencies based on emergence could assist the participants to understand and interpret the operative context (Snowden & Boone 2007), including the problems they encounter.

In a project context, embracing new emergent forms of narrative, namely living story via the antenarrative, facilitates a destabilizing of the dominant BME narrative within organizations and has the potential to re-story our experiences. This opens a door for project managers to develop a new competency based on emergence from outside the current toolbox of project management. In moving along the continuum from traditional project management to complex project management, there is a progressive building of competencies (ICCPM 2012), and quantum storytelling has the potential to add depth to the current inclusion of storytelling skills in the CPM Standards.

Conclusion

This paper illustrates how a storytelling methodology can be used to explore problems on complex projects. The collection of stories deliver data providing insights which contribute to a better understanding of the interpretation of problems by the CPMs on their IDS projects, and the resulting approaches chosen to problem solving.

The data themes provide insights into both the personal and sectoral concerns of the participants, illustrating the storyworld of the issues related to the IDS.

The literature explores the idea that traditional project management methods apply a control frame through which to interpret concepts like "problems" and "issues," but in the real world adaptable, flexible behaviours are needed to tackle problems as they evolve in the field. Therefore, the traditional "plan and manage" contingency approach is not delivering to the IDS project managers the required competencies to manage their complex projects.

One of the almost universal challenges to complex projects is a high number of stakeholders and the complex interactions between them. These issues of "conversational relating" (Cicmil et al. 2006) require a strong competency in leadership to harness the power of storytelling to engage, motivate and create shared meaning amongst stakeholders (ICCPM 2012).

Quantum storytelling, through the living story, enables the reframing of problems by harnessing emergence to view them in their emergent state. It provides a way to reinterpret project concepts assisting project managers to make sense of the dynamic and emergent nature of projects and consider alternative approaches to problem solving.

Quantum storytelling, has the potential to make a contribution to the complex project management standards by adding depth to the notion of storytelling, opening a door for project managers to develop a new competency based on emergence that is complementary to the complex environments in which they find themselves managing.

Limitations and recommendations for future research

The following recommendations are made for future research regarding the methodological limitations:

- Use a larger sample size to support generalizability of the results; more organizations, more participants, more projects of different types.
- Use a longer time frame for the study.

- Conduct multiple interviews and additional interviews.
- Extend the domain of the IDS to include organizations with different funding arrangements or operating across different project types or countries
- Apply forms of micro narrative (Snowden 2012) and "living story" (Boje 1991, 1995, 2001) collection as the in-field processes of actuality research lend itself to this type of research. This would assist to counter the challenge of collecting stories of past events given that human reframe experiences to retrofit a BME perspective (Boje 2008).
- Explore other methods to limit researcher bias in narrative studies than applying the *storytelling diamond model* (Rosile et al. 2013).

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APPENDIX 1 Complexity Dimensions

Complexity Dimensions	Project Profile			
	Level 1: Low Complexity Project	Level 2: Moderately Complex Project	Level 3: Highly Complex Project	Level 4: Highly Complex Program "Megaproject"
1. Size/Time/Cost	**Size:** 3–4 team members **Time:** < 3 months **Cost:** < $250K	**Size:** 5–10 team members **Time:** 3–6 months **Cost:** $250–$1M	**Size:** > 10 team members **Time:** 6 – 12 months **Cost:** > $1M	**Size:** Multiple diverse teams **Time:** Multi-year **Cost:** Multiple Millions
2. Team Composition and Past Performance	• **PM/BA**: competent, experienced • **Team**: internal; worked together in past • **Methodology**: defined, proven	• **PM/BA**: competent, inexperienced • **Team**: internal and external, worked together in past • **Methodology**: defined, unproven • **Contracts**: straightforward • **Contractor Past Performance**: good	• **PM/BA**: competent; poor/no experience with complex projects • **Team**: internal and external, have not worked together in past • **Methodology**: somewhat defined, diverse • **Contracts**: complex • **Contractor Past Performance**: unknown	• **PM/BA**: competent, poor/no experience with megaprojects • **Team**: complex structure of varying competencies and performance records (e.g., contractor, virtual, culturally diverse, outsourced teams) • **Methodology**: undefined, diverse **Contracts**: highly complex • **Contractor Past Performance**: poor
3. Urgency and Flexibility of Cost, Time, and Scope	• **Scope**: minimized • **Milestones**: small • **Schedule/Budget**: flexible	• **Scope**: achievable • **Milestones**: achievable • **Schedule/Budget**: minor variations	• **Scope**: over-ambitious • **Milestones**: over-ambitious, firm • **Schedule/Budget**: inflexible	• **Scope**: aggressive • **Milestones**: aggressive, urgent • **Schedule/Budget**: aggressive
4. Clarity of Problem, Opportunity, Solution	• **Objectives:** defined and clear • **Opportunity/Solution:** easily understood	• **Objectives:** defined, unclear • **Opportunity/Solution:** partially understood	• **Objectives:** defined, ambiguous • **Opportunity/Solution**: ambiguous	• **Objectives:** undefined, uncertain • **Opportunity/Solution:** undefined, groundbreaking, unprecedented
5. Requirements Volatility and Risk	• **Customer Support:** strong • **Requirements:** understood, straightforward, stable • **Functionality**: straightforward	• **Customer Support:** adequate • **Requirements:** understood, unstable • **Functionality:** moderately complex	• **Customer Support:** unknown • **Requirements**: poorly understood, volatile • **Functionality:** highly complex	• **Customer Support:** inadequate • **Requirements**: uncertain, evolving • **Functionality:** many complex "functions of functions"

Complexity Dimensions	Project Profile			
	Level 1: Low Complexity Project	Level 2: Moderately Complex Project	Level 3: Highly Complex Project	Level 4: Highly Complex Program "Megaproject"
6. Strategic Importance, Political Implications, Stakeholders	• **Executive Support:** strong • **Political Implications:** none • **Communications:** straightforward • **Stakeholder Management:** straightforward	• **Executive Support:** adequate • **Political Implications:** minor • **Communications:** challenging • **Stakeholder Management:** 2–3 stakeholder groups	• **Executive Support:** inadequate • **Political Implications:** major, impacts core mission • **Communications:** complex • **Stakeholder Management:** multiple stakeholder groups with conflicting expectations; visible at high levels of the organization	• **Executive Support:** unknown • **Political Implications:** impacts core mission of multiple programs, organizations, states, countries; success critical for competitive or physical survival • **Communications:** arduous • **Stakeholder Management:** multiple organizations, states, countries, regulatory groups; visible at high internal and external levels
7. Level of Change	• **Organizational Change:** impacts a single business unit, one familiar business process, and one IT system • **Commercial Change:** no changes to existing commercial practices	• **Organizational Change:** impacts 2–3 familiar business units, processes, and IT systems • **Commercial Change:** enhancements to existing commercial practices	• **Organizational Change:** impacts the enterprise, spans functional groups or agencies; shifts or transforms many business processes and IT systems • **Commercial Change:** new commercial and cultural practices	• **Organizational Change**: impacts multiple organizations, states, countries; transformative new venture • **Commercial Change:** ground-breaking commercial and cultural practices
8. Risks, Dependencies, and External Constraints	• **Risk Level:** low • **External Constraints:** no external influences • **Integration:** no integration issues • **Potential Damages:** no punitive exposure	• **Risk Level:** moderate • **External Constraints:** some external factors • **Integration:** challenging integration effort • **Potential Damages:** acceptable exposure	• **Risk Level:** high • **External Constraints:** key objectives depend on external factors • **Integration:** significant integration required • **Potential Damages:** significant exposure	• **Risk Level:** very high • **External Constraints:** project success depends largely on multiple external organizations, states, countries, regulators • **Integration:** unprecedented integration effort • **Potential Damages:** unacceptable exposure
9. Level of IT Complexity	• **Technology:** technology is proven and well-understood • **IT Complexity:** application development and legacy integration easily understood	• **Technology:** technology is proven but new to the organization • **IT Complexity:** application development and legacy integration largely understood	• **Technology:** technology is likely to be immature, unproven, complex, and provided by outside vendors • **IT Complexity:** application development and legacy integration poorly understood	• **Technology:** technology requires groundbreaking innovation and unprecedented engineering accomplishments • **IT Complexity:** multiple "systems of systems" to be developed and integrated

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Identification of key supply chain elements for megaprojects success

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Synopsis

Each megaproject influences life on the society level, so megaproject success or failure has another level dimension. In the past, the research community recognized the vital importance of megaprojects for development of a country on the one hand. On the other hand, researched identified strong negative impact that schedule, time and cost overrun (not even mentioning deceptions of public) of megaprojects might have for the development of a country. Recent studies in project management bring up supply chain conception as fertile component for megaproject management development.

Relevance for practice/education

Identification of supply chain elements could have impact on the performance of megaprojects in terms of delay reduction.

Research design

Quantitative methodology was the research design used for this study.

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Main findings

Econometric analysis confirmed a strong relation between dependent variable "delay" on the one side and construction.

Research implications

Our idea was to screen the area and problems to indicate the direction for future research. For more exact relationships and insight, a much wider sample (more than 200 infrastructure megaprojects) should be considered.

Keywords

Supply Chain Management, Megaprojects Success, Supply Chain Elements

Abstract

The objective of the paper is to explore elements of supply chain management within megaprojects and identify the ones that have significant influence on the megaproject performance, thereby providing an idea of the possible influence on megaproject success in general.

Within the theoretical framework, supply chain elements are identified for the megaproject management research field. Based on the chosen megaproject sample and econometric analysis, the presence and the level of identified supply chain elements were tested in the management of megaprojects. Variable construction signifies time needed to build an infrastructure (without planning). Delay is a common problem in infrastructure megaprojects and is often for the reason higher costs are incurred for the project in total. Variable delay in this paper indicates the time needed for the project to be completed. Econometric analysis showed that two variables, delay and construction, are significant for megaproject performance. The discussion of the conducted screening is contained herein so that recommendations can be made for steps for further in-depth research. Authors would like to acknowledge that rigorous mathematical modelling could give important value in better understanding the aspects of delay problem in megaproject management.

Introduction

Today we live in a world of projects, driven by needs, problems or ideas. The concept of project management is trying to respond to all those challenges by directing change from an unsatisfactory pre-project situation for the better one after the project. The state after the project must be aligned with success criteria. A creative and inspiring part of project management responds to the numerous challenges that may affect the success or failure of each project, including at the megaproject level. For decades, one of the essential problems of the project management aspect has been represented by the time and cost overruns. Supply chain management significantly contributes in minimizing the cost and time, with the aim of ensuring delivery of the expected value for the user. Therefore, supply chain could be considered a ground for planning megaprojects with success. The objective of this paper is to identify the main elements of the supply chain in megaproject outcomes. The research question is: to what extent are elements of supply chain related to megaproject success? After the following literature review, the authors describe the method of project selection and its

main characteristics. Then an econometric analysis is carried out by applying selected statistical methods. In the conclusion, the authors state that the most challenging problems that occur in megaprojects relate to delay and construction.

Literature review

The definition of a megaproject is one where spending is over US$1 billion or €0.5 billion. However, small and medium-sized countries have a gross domestic product (GDP) much lower than that of developed countries, so costs for a megaproject could range from €250–300 million. One of the important characteristics of these countries is a great need for developments (infrastructures, energy, public sectors reform, etc.), where megaprojects can have a strong impact on society (Mišić & Radujković 2015). Megaprojects are increasingly used as the preferred delivery model for goods and services across a range of businesses and sectors, including infrastructure, water and energy, information technology, industrial processing plants, mining, supply chains, enterprise systems, strategic corporate initiatives and change programs, mergers and acquisitions, government administrative systems, banking, defence, intelligence, air and space exploration, big science, urban regeneration and major events (Flyvbjerg 2014). Nowadays, most megaprojects operate in an environment with high uncertainty, such as widespread economic fluctuation, population growth, and increasing pressure arising from environmental and resource limitations (Shehu & Akintoye 2010).

During the 1990s, many organizations, both public and private, embraced the discipline of supply chain management (SCM). These organizations adopted several SCM-related concepts, techniques and strategies such as efficient consumer response, continuous replenishment, cycle time reduction, vendor-managed inventory system and so on, to help them a gain a significant competitive advantage in the marketplace. Companies that have effectively managed their total supply chain, as opposed to their individual firm, have experienced substantial reductions in inventory- and logistics-related costs, shorter cycle times and improvements in customer service (Morris & Pinto 2004).

The supply-side component for an organization may be composed of suppliers of basic raw materials and components, along with transportation links and warehouses, and it ends with the internal operations of the company. The inbound component begins where the organization delivers its output to its immediate customer. This portion of the supply chain may include wholesalers, retailers, distribution centres and transportation companies, and it ends with the final consumer in the chain (Morris & Pinto 2004). Although the adoption and implementation of total SCM-related strategies is quite prevalent in the retail and manufacturing industries, and their benefits are well understood, project-based organizations have lagged behind in their acceptance and use of such strategies. For instance, the engineering and construction industry worldwide has been plagued by poor quality, low profit margins, and project cost and schedule overruns (Yeo & Ning 2002). It is estimated that in the construction industry about 40% of the work constitutes non-value-adding activities such as time spent on waiting for approval or for materials to arrive on the project site (Mohammed & Bashir 2015).

Megaprojects as a delivery model for public and private ventures have never been more in demand, and the size and frequency of megaprojects have never been greater. On the other side, performance in megaproject management is strikingly poor and has not improved for the 70-year period for which comparable data are available, at least not when measured in terms of cost overruns, schedule delays and benefit shortfalls (Flyvbjerg 2014). Following on that evidence, most research has focused on the link between SCI and performance; however,

recent literature reviews indicate that the results regarding the relationship between SCI and performance are mixed and not very convincing (Larsson et al. 2015).

From the literature review, project delay was identified as one of the most common problems in the construction industry worldwide. Despite more than 20 years of recent developments in the project management profession, we are still faced with the same challenges regarding cost and time overruns. Several studies investigating the causes of delay in projects in the construction industry have been conducted worldwide. Odeyinka and Yusif (1997) reported that 7 out of 10 projects surveyed in Nigeria suffered delays. According to Assaf and Al-Hejji (2006), 70% of the large construction projects studied in Saudi Arabia experienced average time overruns of between 10% and 30%.

Numerous other data provided by PricewaterhouseCoopers (PWC), World Bank, McKinsey, Standish, or other institution reports confirm this trend. The common methods – the ROF method and projects in construction supply chain performance – can be evaluated by six indicators. According to the analysis and characteristics of projects in the construction supply chain, the evaluation index of projects in supply chain performance are schedule, quality, cost, organizational flexibility, core enterprise satisfaction and partner closeness (Ke et al. 2015). But despite a rich literature in supply chain management domain, indicators to measure the effectiveness of supply chain strategies are rare (Zhao, Flynn & Roth 2006).

However, the simple copy and paste scenario is not valid because the construction business is project-oriented, and so are related megaprojects. Despite the many similarities which apply to all business, megaprojects have a specific context and framework. Each business is under the spiralling pressure of the "bigger-better-faster-cheaper" syndrome, and whatever one did yesterday, it is not enough for today or tomorrow. This dramatically applies to megaprojects, for which the trend has been increasing. Nevertheless, being private or public, each megaproject engages huge resources and high expectations. As the name itself implies, a megaproject is big game, and Merrow (2011) was right by naming them as "creators or destroyers of capital." Therefore, a delay should be considered as one of the most important elements in megaproject management, and SCM influence is extremely interesting and important.

Classification of components in megaproject success

Another important perspective on megaprojects is evaluation of success. Numerous discussions and contributions have been done and published on that topic (Mišić & Radujković 2015). In the case of many megaprojects, the initial evaluation was revised, which implies that megaproject success evaluation is a complex assignment and that it needs a longer time span after delivery or start of usage before it can take place. Frankly, it is not possible to judge the success of a megaproject in a short time or only by basing it on costs alone, because the "megaproject success triangle" includes not only the business perspective but also societal and environmental perspectives (see Figure 1). In most cases, benefits for the particular community or society are a key element for judgement, whereas all types of megaprojects must be judged by their impact on the environment, which basically means analysing what leave to or take from future generations (Radujkovic 2014.).

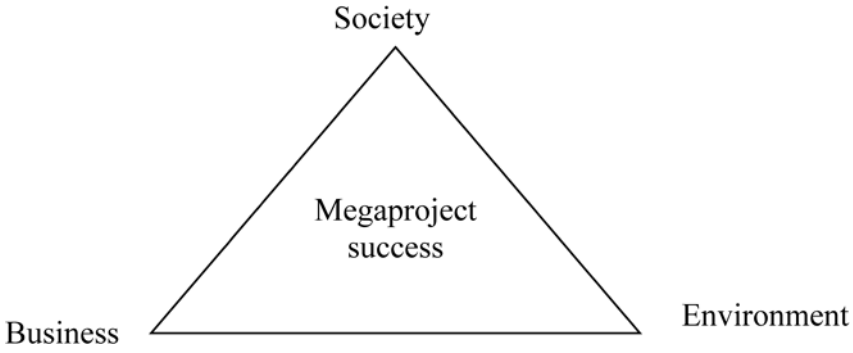

Figure 1 Framework for megaproject success analysis. **Source**: author

So regardless of the type of megaproject, certain community members, or even society itself, are key stakeholders. The management of a megaproject involves far more than "management-by-the-book criteria" or "simple client- or parent organization– oriented management." However, if we approach the problem from any of those angles, we would remove time as a key variable, supposing that delivery fully fits the needs. While analysing megaprojects at the first meeting of IPMA SIG (International Project Management Association, Specific Interest Group Megaproject 2015), it was argued that the inbound, or supply-side, component in a megaproject is longer than any of its separate phases and that it significantly influences timing of each phase, from concept to delivery.

THE CONTEXT OF RESEARCH DESIGN

The main objective of this paper was to identify key elements of supply chain management and to analyse the strength of those variables in megaproject management. Therefore, we conducted a literature review to identify the main elements of SCM and to observe their relation. We have gathered publications from ProQuest, Science Direct, EBSCO, SCOPUS, Emerald and Taylor & Francis. Our search was based on the following key words: "supply chain," "project management," "megaproject," "construction management" and "megaprojects success."

During our work, we had access to respected journals in the fields of operation management, project management and supply chain management. All the papers we selected reflect the current state of the art and profession. The intent of this paper was to screen the literature and to open discussion on supply chain management influence to some of the key supply chain elements while dealing with infrastructure megaprojects. In the paper, an analysis of the supply chain management framework is conducted as the analysis of SCM and selected supply chain elements.

THE CONTEXT OF RESEARCH DESIGN

The context for this research relies on megaprojects in the transport industry. Megaprojects are extremely large-scale investment projects typically costing more than €0.5 billion. Megaprojects include power plant (conventional, nuclear or renewable), oil and gas extraction and processing projects and transport projects such as highways and tunnels, bridges, railways, seaports and even cultural events such as the Olympics. Megaprojects are united by their extreme complexity (both in technical and human terms) and by a long record of poor delivery (Brooks 2015). The performance of megaprojects has long been seen as problematic in terms of overall on-time and to-budget delivery and in terms of the utility of the megaproject once in

operation (i.e. the megaproject does produce the intended societal benefits). The proportion of megaproject delivery failure has been put as high as 66% (Magnusen & Samset 2005). Some of the key problems encountered in major projects are cost overruns, tactical budgeting, a narrow planning perspective, the wrong choice of concept and the adverse effect of uncertainties (Magnusenm & Samset 2005). It is estimated that in the construction industry, about 40% of the work constitutes non-value-adding activities such as time spent on waiting for approval or for materials to arrive on the project site (Mohammed & Bashir 2015). The infrastructure of megaprojects is not considered in this paper, so we are talking about construction here and how the supply chain might influence its success.

Based on literature review findings, as well as our own previous research (Mišić & Radujković 2015), we selected 11 variables for analysis. Those variables are considered to be basic and significant for megaprojects management as well as for construction management and supply chain management. These variables are predicted cost (in billion euros), actual cost (in billion euros), project completed (over or under budget), funding (private or public), months in planning, months in construction, project completed (in months), workforce price, approach to supply chain project logistics and procurement.

DATA COLLECTION

The screening and analysis are based on an example database of 29 case studies of megaprojects from OMEGA (OMEGA 2012). The case studies are mentioned in the Table 1. Data were averaged (cross-sectional data) and referred to the sample size of n = 29 (included observations).

Table 1 List of megaprojects

No	Continent	Country	Name of the Project
1	Australia	Australia	CityLink Melbourne – providing supply
2	Australia	Australia	Cross City Tunnel parking supply
3	Australia	Australia	South West Railway supply
4	Europe	France	France Meteor
5	Europe	France	France Millau
6	Europe	France	France TGV
7	Europe	Germany	NBS_Cologne supply duty power
8	Europe	Germany	Tiergartentunnel
9	Europe	Germany	BAB20
10	Europe	Greece	Rionantrion
11	Europe	Greece	Athensmetro
12	Europe	Greece	Attiki Odos
13	Europe	Hong Kong	Airtrain
14	Europe	Hong Kong	West Harbour
15	Europe	Hong Kong	West Rail
16	Asia	Japan	Ōedo Line
17	Asia	Japan	Shinkansen
18	Asia	Japan	Shinjuku
19	Europe	Netherlands	HSL Zuid

Table 1 continued

20	Europe	Netherlands	Randstadrail
21	Europe	Netherlands	Beneluxlijn
22	Europe	Sweden	Arlanda Rail Link
23	Europe	Sweden	Oresund Link
24	Europe	Sweden	Sodralanken
25	Europe	UK	Channel Tunnel Rail
26	Europe	UK	Jubilee Line Extension
27	USA	New York	Airtrain
28	USA	California	Alameda Corridor
29	USA	Massachusetts	Central Artery

Source: OMEGA Centre, Megaprojects Executive Summary, University College London, UK, 2012

From the literature review, we identified the most important elements of the supply chain (Table 2).

Table 2 Elements of the supply chain

Author	Year	Variable of SC
Cooper & Ellram (1993)	1993	Inventory management approach, total cost approach, time horizon, amount of information sharing and monitoring, amount of coordination of multiple levels in the channel, joint planning, compatibility of corporate philosophies, breadth of supplier base, channel leadership, amount of sharing risks and rewards, speed of operations, information and inventory flows
Cooper, Lambert & Pagh (1997)	1997	Service, cost, productivity asset/utilization, time
McAdam & McCormack (2001)	2000	Delivery to original promise date, faultless installs, bid management cycle times, order fulfilment lead time, delivery to customer requested date, cash to cash cycle time, upside production flexibility, total supply chain management cost, bid management costs, inventory days of supply
Hong et al. (2011)	2011	Schedule, quality, cost
Hong et al. (2011) Cheng et al. (2010)	2011	Reliability, quick response, flexibility, cost, asset, utilization ratio
Hong et al. (2011)	2011	Satisfaction of core enterprise, affinity of partner
Goh & Eldridge (2015)	2015	Product type, product unit value, lifecycle, demand variability, fulfilment strategy, key supply chain metric, S&OP stage, enterprise resource planning and data warehousing system

Source: authors

The purpose of this study was to identify elements of supply chain that have impact on the performance of megaprojects. It was found that supply chain management is very well known in the manufacturing, oil and gas, and construction industries, but it is not so understood within megaprojects management. We did not delve deeply into the processes of supply chain activities; rather, we wanted to capture a general picture of the main elements of SCM in relation to megaproject success. Therefore, we see now that there is a call for further research of other, different elements within various processes of supply chain management activity.

In most of the models of estimated regression analysed in this paper, coefficients were not statistically significant because of the rather small sample (29 infrastructure megaprojects). Initial screening suggested the following variables for detailed statistical analysis: *delay* (in terms of months; can be negative if the item is before deadline or positive if the item is out of schedule); *under budget* (deviation of the budget as a percentage difference between actual and overlooked cost of megaproject), which can be negative if the actual cost is higher than forecasted, and vice versa; *private* (% of private funding); *planning* (time in months); and *construction duration* (time in months).

Data analysis and discussion

In the analysis that was done (based on the data set) the most significant model is shown in Table 3. This model was analysed with the dependent variable "Delay." This variable was marked as dependent because of the relevance dedicated to delay as a problematic element in infrastructure megaprojects in academic research done so far. In this sphere, first we estimated the model that contains only the constant member (it is a "variable C" in the EViews 8.0. software records). The method that was used to estimate the coefficients was ordinary least squares (OLS) method.

Table 3 Analysis with numerical variables

Dependent Variable: Delay				
Method: Least Squares				
Sample: 129				
Included observations: 29				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	–5.252805	11.30016	–0.464843	0.6462
Under Budget	–0.183842	0.123761	–1.485462	0.1504
Private	–0.019854	0.116027	–0.171114	0.8656
Construction	0.288506	0.085304	3.382072	0.0025
Planning	0.003081	0.044835	0.068721	0.9458
R-squared	0.539671	Mean dependent var		26.58621
Adjusted R-squared	0.462950	S.D. dependent var		30.20586
S.E. of regression	22.13598	Akaike info criterion		9.187871
Sum squared resid	11760.04	Schwarz criterion		9.423612
Log likelihood	–128.2241	Hannan-Quinn criter.		9.261702
F-statistic	7.034161	Durbin-Watson stat		1.844509
Prob (F-statistic)	0.000677			

In the final part of the econometric analysis, we set out with numerical variables.

Model can be written as:

$E(Y)$= -5,252805 - 0,183842X_1 - 0,019854X_2 + 0,288506X_3 + 0,003081X_4 where variable Y = Delay, Under Budget, X_2 = Private , X_3 =Construction and X_4 =Planning.

Here we were very careful because the estimated coefficients are interpreted differently when the numerical variables in relation to the first part of the analysis, where variables were "dummies." According to the above estimated model, for example, the greater the percentage of private funding, the less delay can be expected (for 1% of private funding delay is reduced by 0.019854 month). It can be seen that the construction time significantly affects the delay, that is, increase of construction time for one month will cause a delay completion of the megaproject for 0.2885 month (which is approximately nine days). Similarly, other estimated coefficients can be interpreted in the same way, with only one of them statistically significant (Construction), although it is now an R-squared value (i.e. coefficient of determination) and is slightly better than the previous models (model was interpreted 53.967% of total deviations). This is not a strong significance. Durbin-Watson is close to 2, which is good (DE = 1.8445), and the F-test is also good, because Prob(F-statistics) is close to zero.

The regression analysis on 29 megaprojects was used for screening this way: where to look when we talk about supply chain in infrastructure megaprojects. The sample used is fair for the screening purpose, but still not big enough for declaring the algorithm which reflects the general case. Our screening analysis showed several interesting findings. First, the expected findings that megaprojects are suffering by delays and SCM should be considered as one of the significant variables for megaproject management. The presence of the SCM in a megaproject management contributes to reducing delay time. By combining theories of SCM and procurement process, the positive effect will be even greater. The other point of the findings confirms that private funding also influences delay reductions, possibly by better use of SCM. It can be expected that the megaproject will be completed ahead of schedule, on average 6.5 months if the supply chain and procurement are present, irrespective of logistics. And finally, it is shown that construction time significantly affects the delay; that is, an increase in construction time for one month will cause a delay for completion of the megaproject for 0.2885 month (which is approximately nine days). Between limited rationality and self-interest, adaptable supply chain initiatives may give megaprojects performance strong criteria for superior performance, managing their construction activities and reducing delay as well as costs. The "doing more with less" or "better-bigger-faster-cheaper" syndrome becomes the mantra of organizations that seek to survive in a resource-constrained world. Eco-efficiency considerations will drive many supply chain decisions, as companies seek to reduce both their use of scarce resources and their costs (Christopher 2011). When dealing with megaprojects, this leads to another, human dimension, because such megaprojects influence the life of many people in a particular community. So, each scenario leading to a delay of megaproject delivery is a huge problem. Our screening research showed the direction for how SCM can make a positive effect to megaproject delivery and therefore to better community prosperity.

Conclusions

This paper offers screening of the important factors related to supply chain challenges in megaprojects. The analysis resulted in an indication that delay and construction are significant variables in relation to megaproject duration, and that supply chain is important for dealing with the topic of performance as regards infrastructure megaprojects. The objective of the

paper was achieved: we found significant elements of supply chain and tested their relevance on the OMEGA database. The limitations of this paper are related to the number of megaprojects that were taken into the account: the analysis would be more rigorous if we had more than 200 megaprojects; and according to Flyvbjerg, Bruzelius and Rothengatte (2003), this should be taken into account in order to come to the proper conclusions. Our idea was screening the area and problems, with purpose of indicating the direction for future research. For more exact relationships and insight, a much wider sample (more than 200 infrastructure megaprojects) should be considered. However, our analysis confirmed the research observation mentioned in the literature. This paper shows promising initial results for the first level of the research, and we think there is reason to go further with this research. The research was conducted in order to identify key aspects of supply chain in megaprojects and to show the path for future research that will delve more deeply into this subject. The future results would be even more valuable if other types of megaprojects were analysed. It is possible to use the methodology employed to conduct this research for different types of megaprojects.

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CONFERENCE PAPER

The Agile Mindset for Project Management

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Synopsis

We describe Agile in three ideas: satisfy the customer, engage the team, and simplify everything. All ideas from a recently updated *Agile Manifesto* fit in our three-idea framework. We also considered all ideas from the *PMI Agile Certification Outline* and had Agile experts prioritize them. The resulting important ideas all fit in the three-idea framework. Collectively, these explain why Agile is useful and how to perform it. We conclude by explaining values, benefits and actions of Agile.

Research Design

There were multiple parts to this research design. First was extensive practice using Agile while studying for and passing several Agile certification exams. As an outgrowth of this practice and study, in 2016 an update to the *Agile Manifesto* was written with an eye towards current practice in both IT projects and a variety of other contexts to update and broaden the relevance. The updated manifesto contains four values and 13 processes, just as the original manifesto did. Then we brainstormed and created the simple three-part model dealing with customer, team and simplification.

To further validate, we used the *PMI Agile Certification Outline* as a standard that had input from many people and is widely accepted. We de-duplicated a few items that occurred

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repeatedly and used the remaining 37 items as survey items. We asked a number of experts who each have at least 20 years of project management experience, including both traditional and Agile to prioritize the de-duplicated items. We ended up with 23 items that were considered to be important by at least half of the experts.

Relevance to Practice and Education

These findings are relevant to practice, as Agile is often described in various ways and may be poorly understood. Many practitioners who attempt Agile focus on one or a few aspects, rather than the totality, and are likely to be disappointed in their results. Agile may be at a point, like TQM was a generation ago, with great popularity, but poor understanding. It could suffer from the same fate, with better organizations receiving substantial benefits, but many other organizations finding poor results unless it is easily understood. This is an attempt to help Agile to be better understood.

The findings are relevant for teaching as this is a simple organizing framework that has been shown to incorporate all of the more important Agile ideas. This can be taught as a primer on Agile or easily incorporated into a broader course on project management.

Main Findings

All four values and 13 principles from the updated *Agile Manifesto* fit neatly into one of the three categories of customer, team and simplification.

All 23 prioritized items from the *PMI Agile Certification Outline* map directly into one of the three categories of customer, team and simplification.

The items from the updated manifesto largely explain why Agile is useful, while the prioritized items from the PMI outline largely explain how to perform Agile.

Research Implications

This was a small-scale pilot study. A larger study might bring out more nuances of how to perform Agile and why certain items are more valuable than others. Although this concisely summarizes the most important aspects of Agile into a simple framework, further study may indicate that certain items are more important to perform quickly when adapting to Agile or might be better suited to projects in a particular industry or other context.

Keywords

Agile, Project, Project Management, Customer Satisfaction, Team, Team Engagement, Simplification, Leadership, Value, Principle

The Agile Mindset for Project Management

Agile is a form of adaptive or change-driven project management in which PM is largely reacting to what has happened in the early stages of a project rather than planning everything in detail from the start. Documentation is minimal early in the project but becomes progressively more complete. To understand Agile, one needs to know both the methods and the mindset of Agile practice. For the methods, a project vision is developed and shared early. Project teams plan in short bursts (generally of one to four weeks) often called sprints or

iterations. The details are planned for the upcoming iteration, and very little change is allowed during it. Products are defined and delivered one iteration at a time, with an output that has business value successfully finished in each iteration. Then the next iteration is planned. The mindset is empowering, engaging and enables open communication, as detailed below.

The word *Agile* has become synonymous with change in technology organizations large and small; however, there is an emerging misconception of how Agile can be used to make a significant change in complex endeavours. Most of the books on this subject focus on identifying the mechanics of a particular practice within the Agile space, but fail to define the overarching thinking that makes them so effective. These include, but are not limited to, the use of Scrum, XP or Kanban. Although these are necessary works and lay the foundation for Agile practices, they do not address the mindset shift needed to take full advantage of these practices. The misconception is further extended by the use of traditional project management words to explain similar concepts within Agile without drawing clear distinctions. It is left to leaders to figure out what the difference is and how they need to think differently in order to get the outsized gains attributed to Agile as reported in numerous case studies. Without the firm and deliberate transition to a new way of thinking about teams and how teams work differently with Agile practices, Agile will quickly devolve into a semantic equivalency that will leave executives more frustrated by the failure of another approach that degrades their ability to unlock the performance potential of their organization and their teams, and capitalize on the individual knowledge of team members.

Agile has grown tremendously in popularity in the last few years. Although it was originally conceived and described as being useful for software development projects, many people involved in other types of development projects have begun to experiment with and often embrace it.

Our concern is that Agile might follow the path of total quality management (TQM) from the 1990s. TQM also emerged from a frustration in current management techniques. The difference is that TQM was oriented towards managing an ongoing organization, whereas Agile is aimed at managing a software project. The old way of managing for quality was to develop or produce a product and then test it. It was deemed to be either acceptable or not. Adherents of TQM correctly saw this as a wasteful and sloppy way of doing things. Therefore, they proposed a dramatically different approach that emphasized stakeholder satisfaction, empowered performance, process improvement and management by facts.[2] This new approach helped many organizations vastly improve their quality and competitiveness. Unfortunately, there was no broad consensus of exactly what constituted TQM. Some advocates emphasized management by facts driven largely by statistical analysis; others emphasized the importance of front-line workers making decisions. The result was that although many of the better-managed organizations reaped substantial benefits from incorporating TQM ideas and techniques into their management systems, many other organizations wasted time and effort before giving up. Are we at such a crossroads on Agile? Like TQM, Agile has multiple aspects, and one cannot cherry-pick the few they like. For it to work best, leaders need to understand the whole of it.

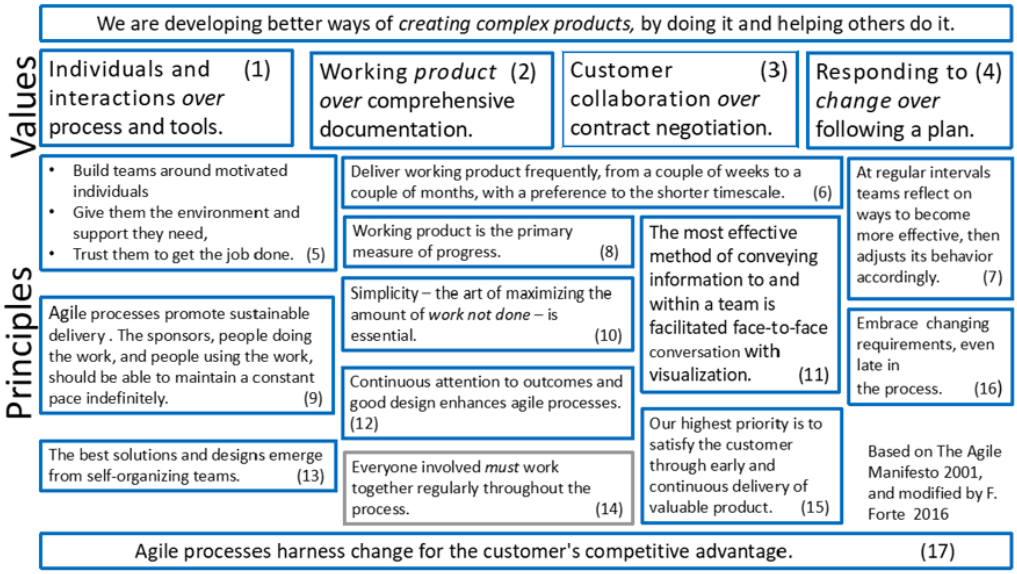
Therefore, we decided to describe Agile as three simple ideas. Each of these ideas can be expanded upon, but having an easy way to describe and remember the various aspects of Agile may help to promote common understanding and acceptance.

The three simple ideas are as follows:

1. Satisfy the customer.
2. Engage the team.
3. Simplify everything.

Then we went in two directions to see how they converge. First, we rewrote the Agile Manifesto, updating it according to effective practice and describing it in such a manner to be relevant to many types of projects rather than just software development. Our updated Manifesto is shown in Exhibit 1.

Exhibit 1 Agile manifesto updated



With that done, we map the updated Manifesto on the three main topic categories to see how they fit. This forms the values and principles behind Agile, organized in a simple manner. Our updated Manifesto mapped to the customer, team and simplicity is shown in Exhibit 2.

Exhibit 2 Updated Agile Manifesto Mapped to Three Ideas

1. **Satisfy the customer:**

- Value customer collaboration *more than* contract negotiation.
- Our highest priority is to satisfy the customer through early and continuous delivery of valuable *product*.
- Embrace *changing* requirements, even late in the process.
- Agile processes harness *change* for the customer's competitive advantage.

2. **Engage the team:**

- Value Individuals and interactions *more than* process and tools.
- Build *teams* around motivated individuals.
- Give them the environment and support they need.
- Trust them to get the job done.
- Agile processes promote sustainable *delivery*. The sponsors, people doing the work and people using the work, should be able to maintain a constant pace indefinitely.
- The most effective method of conveying information to and within a team is *facilitated face-to-face conversation* with *visualization*.
- The best *solutions* and designs emerge from self-organizing teams.
- *Everyone* involved *must* work together regularly throughout the process.

3. **Simplify everything:**

- Value working *product more than* comprehensive documentation.
- Value responding to *change* more than following a plan.
- Deliver working *product* frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
- At regular intervals, *teams* reflect on ways to become more effective and then adjust their behaviour accordingly.
- Working *product* is the primary measure of progress.
- Simplicity – the art of maximizing the amount of *work not done* – is essential.
- Continuous attention to outcomes and good design enhances Agile processes.

Next we looked at the *PMI Agile Certification Outline* and asked leading practitioners and writers to prioritize among the many ideas. Which are truly important? Then we group those ideas into the same three topic areas. These are more action-oriented and form the methods that can be used to implement Agile, again explained in a simple manner. We started with all of the tasks identified in the *PMI Agile Certification Outline*. We used our judgment to de-duplicate similar terms, reducing the number of tasks to 37, as shown in Exhibit 3. These 37 items are listed in the order in which they appeared in the *PMI Agile Certification Outline*.

Exhibit 3 Agile tasks paraphrased and de-duplicated from PMI-ACP Exam content outline

1. Maintain highly visible information registers.
2. Allow people to experiment.
3. Encourage collaboration.
4. Encourage emergent leadership.
5. Practise servant leadership.
6. Define and deliver products incrementally.
7. Gain consensus on acceptance criteria on a JIT basis.
8. Tailor the project and team processes.
9. Solicit stakeholder feedback early and often.
10. Prioritize collaboratively.
11. Reprioritize as conditions change.
12. Engage an empowered business stakeholder.
13. Promote knowledge sharing.
14. Form working agreements.
15. Engage new stakeholders as needed.
16. Foster group decision-making and conflict resolution.
17. Establish a shared vision.
18. Ensure common understanding of success criteria.
19. Balance need for certainty with adaptability.
20. Cooperatively devise ground rules.
21. Encourage team members to become generalized specialists.
22. Discover team and individual motivators.
23. Co-locate or use collaborative tools.
24. Reduce distractions.
25. Align project and team goals through sharing vision.
26. Measure velocity in order to better predict.
27. Plan at multiple levels.

28. Include stakeholders in transparent planning.
29. Make increasingly specific commitments.
30. Use retrospectives to create better plans.
31. Adapt plans to reflect changes.
32. Initially create high-level estimates.
33. Refine estimates as your understanding increases.
34. Have appropriate team members resolve issues.
35. Maintain a visible, monitored, prioritized risk list.
36. Conduct frequent retrospectives.
37. Perform value-stream analysis[1]

Then we sent a survey to experienced project professionals, three of whom had written or are writing books on Agile, with most of the others having had significant experience facilitating Agile projects. All have had at least 20 years of project leadership–related experience, generally running PMOs or consulting. We asked the survey respondents to identify up to 25 tasks they felt were most important. Eight of them responded. Of the 37 initial items, 12 were prioritized by more than half of the respondents, and another 11 were prioritized by exactly half of the respondents. Those items are listed in Exhibit 4. Once again, within their prioritization group of half or more than half, they are in the order listed in the *PMI Agile Certification Outline*.

Exhibit 4 Prioritized Agile Tasks

TASKS PRIORITIZED BY MORE THAN HALF OF THE RESPONDENTS

- Encourage collaboration.
- Practise servant leadership.
- Define and deliver products incrementally.
- Solicit stakeholder feedback early and often.
- Reprioritize as conditions change.
- Engage an empowered business stakeholder,
- Promote knowledge sharing.
- Cooperatively devise ground rules.
- Co-locate or use collaborative tools.
- Refine estimates as your understanding increases.
- Maintain a visible, monitored, prioritized risk list.
- Conduct frequent retrospectives.

TASKS PRIORITIZED BY EXACTLY HALF OF THE RESPONDENTS

- Maintain highly visible information registers.
- Tailor the project and team process.
- Prioritize collaboratively.
- Form working agreements.
- Establish a shared vision.
- Ensure common understanding of the success criteria.
- Discover team and individual motivators.
- Reduce distractions.
- Align project and team goals through vision sharing.
- Adapt plans to reflect changes.
- Have appropriate team members resolve issues.

To make these long lists actionable, we grouped those into these three logical groups, as shown in Exhibit 5.

Exhibit 5 Key Agile Tasks from PMI-ACP Outline Mapped onto Three Key Agile Mindset Ideas

Satisfy customers by placing emphasis on outputs that satisfy their needs,

- Engage an empowered business stakeholder.
- Establish a shared vision.
- Ensure common understanding of success criteria.
- Solicit stakeholder feedback early and often.

Engage the team through empowerment, cooperation, knowledge sharing, servant leadership and visible and continual communication.

- Cooperatively devise ground rules.
- Discover team and individual motivators.
- Prioritize collaboratively.
- Have appropriate team members resolve issues.
- Practise servant leadership.
- Co-locate or use collaborative tools.
- Form working agreements.
- Reduce distractions.
- Encourage collaboration.
- Promote knowledge sharing.
- Maintain a visible, monitored, prioritized risk list.
- Maintain highly visible information registers.

Simplify everything with a sustainable cadence and emphasis on process improvement.

- Tailor the project and team process.
- Define and deliver products incrementally.
- Refine estimates as your understanding increases.
- Reprioritize as conditions change.
- Adapt plans to reflect changes.
- Conduct frequent retrospectives.

Now we tie it all together in Exhibit 6 by showing both the values and beliefs that answer the question of why we do Agile and the tasks that show how, mapped together on the three simple ideas of customers, teams, and simplicity.

Exhibit 6: The Why and How of Agile

1. Satisfy the Customer

Why	How
• Value customer collaboration *over* contract negotiation. • Our highest priority is to satisfy the customer through early and continuous delivery of valuable *product*. • *Embrace changing* requirements, even late in the process. • Agile *processes* harness *change* for the customer's competitive advantage.	• Solicit stakeholder feedback early and often • Engage an empowered business stakeholder • Establish a shared vision • Ensure common understanding of success criteria

2. Engage the Team

Why	How
• Value Individuals and interactions over process and tools. • Build teams around motivated individuals. Give them the environment and support they need. • Trust them to get the job done. • Agile processes promote sustainable delivery. The sponsors, people doing the work, and people using the work, should be able to maintain a constant pace indefinitely. • The most effective method of conveying information to and within a team is facilitated face-to-face conversation with visualization. • The best solutions and designs emerge from self-organizing teams. • Everyone involved must work together regularly throughout the process.	• Maintain highly visible information registers • Encourage collaboration • Practice servant leadership • Prioritize collaboratively • Promote knowledge sharing • Form working agreements • Cooperatively devise ground rules • Discover team and individual motivators • Co-locate or use collaborative tools • Reduce distractions • Have appropriate team members resolve issues • Maintain a visible, monitored, prioritized risk list

3. Simplify Everything

Why	How
• Value Working product over comprehensive documentation. • Value Responding to change over following a plan. • Deliver working product frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale. • At regular intervals teams reflect on ways to become more effective, then adjusts its behavior accordingly. • Working product is the primary measure of progress. • Simplicity – the art of maximizing the amount of work not done – is essential. • Continuous attention to outcomes and good design enhances agile processes.	• Define and deliver products incrementally • Tailor the project and team processes • Refine estimates as your understanding increases • Reprioritize as conditions change • Adapt plans to reflect changes • Conduct frequent retrospectives

Finally, we offer some explanations of the values, beliefs and actions of Agile.

Satisfy customers by placing emphasis on outputs that satisfy their needs:

This is a broad view of what Agile would call delivering value. It is further defined by what value means. In the context of complex products, this normally means software. So, the idea here is to deliver working software with every iteration. This departs from the idea that a document or a test plan would be of value to the customer if the product of the effort is software. Although other items may be considered necessary by the customer for regulatory reasons, these could be considered the cost of doing business and should be minimized whenever possible, with the primary focus being the working software every two weeks or so. This prioritizes the customer's needs based on what the product being built is supposed to be.

Think about this in the context of a physical building. Although there is value in the models and drawings of the building, they are not in and of themselves the building. They are cost to getting a building. If you spend more time and effort on the drawing and models than is required, this surfeit becomes waste, no longer adding value to the product. This is a fairly easy concept to understand within the physical realm; however, for the world of complex products, it is not as clear. This is often because we do not understand how we get to good software. The Standish survey on software product value indicates that up to 80% of the software functions created are never used. That is a large number of hours spent designing functions that are not adding value. The way Agile approaches this problem is by asking the customer what would add value next, in short intervals. At some point along this journey, the customer will probably need to pause and digest what she or he has and get feedback from other users before requesting additional features. You will notice how different this approach is from the traditional requirements-driven model used in traditional software development.

What tends to make this Agile approach unique to some and revolutionary to others is that we have used the physical world of project management and applied it to the virtual

world of software products. This metaphor was useful in the early days of software when we were constrained by physics, whether those physics were in the form of real-time physical systems, like missile guidance systems, or whether those constraints involved the limitations of the computing power, memory or disk space. As we have moved away from the physical constraints and limitations, we have had a proliferation of software products. This proliferation has spawned increasing complexity. It has not necessarily driven a better understanding of how to deliver working product cheaper, better, faster.

Now that we are experimenting with alternative ways of delivering value to the customer, we have an opportunity to think differently about what that means.

To summarize, we need to deliver value in very short intervals and get feedback before we build more. This allows us, as creators of complex products, to pivot along the product life cycle.

Engage all participants through empowerment, cooperation, knowledge sharing, servant leadership and visible and continual communication:

Without servant leadership, there cannot be empowered teams. In reality we cannot empower anyone; they must empower themselves, and they will not do that as long as the risk of empowerment is larger than the risk of not doing so. The environment must create the structure, set the behaviours taught and learned, and then the servant leaders can act as guides and coaches on how each team and team member can become more self-organized. This is the journey that is "being agile." Empowered teams come out of the process; we cannot start with teams that are empowered, especially if they have been other than empowered in the past. So, although this is one of the first things on our list and grouping, it is the result or benefit of the other areas discussed.

Cooperation is key to the development of self-organizing teams that behave in an empowered way over time. It is not easy to get cooperation within the corporate structures of today's organizations. We have tried for years to have matrixed organizations that come together in an ideal way for short periods of time. However, we often do not allow enough time for the team development process to take place, and then if we do, we break up the team up as soon as the work is completed instead of having that high-performing team focus on the product and allowing the team members to grow with one another and the product. Cooperation does not come easily; there must be trust before there can be cooperation, and for true cooperation there is going to need to be space for conflict. So the servant leader will need to be comfortable facilitating conflict and at times help to draw it out. This is the way of progress and maturity for the team, without which there will be little improvement at being agile.

Sharing becomes organic in high-performing, cross-functional teams. There is a desire to break down barriers and to become expert on the product. This will only happen when the team feels a sense of ownership with the product and a sense of commitment to the team. There is a need to create a team identity, have ways of working and be able to exhibit good-natured fun and to give one another a hard time to make sure everyone knows that the team's on the hook for the commitment. The knowledge sharing within Agile happens for the product, the process and the team. The more knowledge there is in these three areas, the more Agile can be practised, and the more likely it is for the team to truly become agile. As they become more agile, they develop less of a need for process.

All leadership, if done properly, is servant leadership. Now that is not to say that there are not leaders who want to be served. That is not the leadership style we refer to within the context of Agile principles. It does not mean that the leaders within the Agile movement are just there to do the bidding of the team either. Often people give the pat answer of the servant leader within Agile as being there to remove impediments, sometimes called blockers, in order for the team to meet its commitments. Although this is an example of how a leader may serve the needs of the team, it is but a trivial example. We see this example as a worthwhile activity for a servant leader only until that leader can help team members figure out how to remove their own impediments. Many traditional leaders are actually just managers, and the distinction I draw is that we manage *things* but lead *people*. We are only leading people as long as they are following. If they are following us, then we are leading. Following is something one does out of one's own volition. So there is a higher-level form of leadership in the Agile model than in traditional project management. Historically, in my experience the leaders within traditional projects were really managers, managing tasks and tracking progress through reporting.

The other key in the Agile organization is that there is a defused leadership model where there is not one servant leader. The traditional roles are now split into focus areas – process, product, the how and so on. Because there are more opportunities for leadership, there is a need for disciples to "stay within the swim lane" they are assigned to and refrain from commenting outside their remit. If this can be done and there are people in the servant leadership roles, we begin to see the benefits of this safety net of servant leadership designed to support and empower the team. We then begin to shift the focus from the leader onto the led.

To create, we must have conversation if we are creating together. The level of conversation becomes of higher quality as we add visual aids to that communication. We try to bring the physical realm into all team communication, whether that involves only moving a story card on a kanban board or using whiteboards or other visual means to communicate ideas, design or concepts. Let's face it: we have been communicating as a species much longer with drawings than with words. Visual communication supports a key concept of Agile, and that is transparency. With transparency we expose the lack of understanding and lack of clarity. Once exposed, we are able to address real issues as a team. The more we drive transparency, the better we can collaborate and create. It seems that the lack of transparency comes from a lack of trust, and that comes from how teams are formed and developed. If we can at least do benign things, for example document the work on a 3×5 card and talk about the card every morning, and if we are willing to have people ask questions, we have begun the process. Although this sounds trivial, we are amazed at how much better teams perform after they begin to do this. Many of the diagnostic tools we use with teams are by observation. If we see team members looking at the kanban board instead of looking at one another when talking about their work, we understand there is a lack of trust and openness. This is another aspect of visual within Agile: the value is in the seeing the state of the information, the work, the people or anything else that will impact the product. Once visibility begins to happen, we can start understanding what we may want to experiment with to improve our effectiveness. More on this is explained in a later section.

When we try to be efficient with our conversation, we set ourselves up for failure as a team. We can have short conversations when we work mostly independently of others. If we were able to deterministically break very complex creative efforts into discrete tasks and know we had addressed all the potential problems, we could be independent of the other creators. This is not the case with emerging creative works. How could it be? The person who is asking

us to create does not yet know what "good" looks like, so how could we, the team of people being asked to create, understand what "good" looks like? It is through continual conversation that we explore and learn what each team member is thinking and creating. It is through the ceremonies of Agile techniques like scrum that the team plans and reflects on what is working and what to improve next. It is through the system demonstration that we learn what the customer thinks of our work and understand what the customer would like us to apply our creative talents towards next. In parallel, the team also reflects on how the work was done for the prior iteration, typically two weeks, and considers how it will improve. This, again, is a conversation.

Keep things simple with a sustainable pace or (and) cadence and emphasis on process improvement.

Minimal process is a hallmark of Agile thinking. "Lightweight process" was how the first draft of the Agile manifesto described the thinking. It was later determined that the signatories did not want to be known as lightweights. It is one of the principles of Agile to figure out what *not* to do, termed *work not done*. We need to focus our efforts in that direction when we evaluate our ways of working. If we are trying to enable people not to have to communicate, we are unnecessarily complicating the process. So the more we communicate face-to-face, another Agile principle, the less process we need. This is obvious in our personal lives, but somehow in our business lives we have eliminated face-to-face communication in the name of efficiency.

In particular, for products that are complex and where the product cannot be well described, we actually need less efficiency and more conversation. The model within Agile practices is to start with a few principles and values and see what else is needed for it to work, looking towards reducing the need for process as the team matures. If a team that is self-organizing is able to stay together for longer periods of time and work on the same long-lived product, less process is needed. The process tree must be continually pruned to ensure that the processes being used by the team are as lightweight as possible for any given team at any given time. Without this relentless quest for the minimal viable process, we are doing the customer a disservice by slowing down the value delivery with unnecessary process.

One example of waste is how often within Agile practices teams try to get better with estimating their velocity instead of eliminating the need to estimate at all. If we could assure a customer that our teams will produce what they say they will when they commit and that they will continue to get better over time, the obsession with estimating would be waste and eliminated. A process once outlived becomes an impediment to producing more value more quickly for the customer.

The pace of creation must be measured and metred to be optimal. If we provide too much time between idea conception and delivery, we allow the work to expand and we bump up against the principle of work not done. If we allow that to happen because we do not understand the work that needs to be done, we will surely do too much. The "too much" will not be valued by the customer and therefore becomes waste. Pace plays a critical role in preventing waste by allowing the team to determine its pace and by not telling the team how much to get done in a time interval, but allowing it to continually ask itself how to get better through process improvement. Once we have our minimum time interval we need to ensure we pace ourselves to be able to create at a level of acceptable quality, and to have that pace for a long period of time.

This is the opposite of the legendary death marches software projects have historically undertaken to complete work on time. Once we establish our pace, we again reflect periodically on how we can improve upon that pace. It may be by investing in tools or by a new process, or even by the elimination of process. It may be through cross-training the team or other things the team may look at and experiment with. So, once a sustainable pace is created, it is then exposed to inspection, reflection and improvement, as are all the other areas of thinking in an Agile way.

Whereas pace speaks to how fast we are going, cadence speaks to how often we coordinate our activities. When we scale to larger efforts, we will have dependencies on other cross-functional self-organizing teams. These teams, like our team, are working through the groupings above, and although that is happening, we need to have a common cadence to ensure we are all building in the same direction when we have dependencies and need other teams to help us deliver value to our common larger customer. If we can do that coordination at predictable, predetermined times, we then are able to focus on our own team commitments without constant conversation.

Now, here is where some apparent contradiction may be seen. We want constant conversation at the team level, but we do not want constant conversation outside the team level. Correct. The creative unit is the team, ideally seven members, plus or minus two. That is where the magic happens. As communication channels get larger or when they are not continual, instead of continual conversation we need to have highly coordinated communication. Everyone being on cadence does this. Think of a marching band: if there were no cadence, there would be no music. The music is the creative process, and cadence allows that to happen in a synchronized manner. The mistake we often see is that we do not know well enough what the dependencies are so we expose all information at the higher levels, expecting someone else to identify our dependencies. This is not useful or productive. The mechanism used to prevent this behaviour is commitment. After these cadence events, teams commit to producing working product and demonstrating this product to the customer and eliciting feedback. This commitment, if taken seriously, will drive transparency and the opportunities to get better over time.

Woven throughout these three areas, we see the ideas of process improvement and the ultimate desire to eliminate the need for process. It is the combination of *kaizen*, meaning "continuous improvement," and the idea of relentless reflection that helps us get to the ultimate utility of only delivering value to the customer. We are accustomed to hearing about continuous improvement, but the other side of the same coin is *hansei* – "relentless refection." This is the principle of stopping and reflecting on how to get better as a team. Within Agile, this is done with the ceremony of the retrospective; and at the larger scales, with inspecting and adapting. Although these are not new concepts within the software creation process, the discipline around these concepts is.

Again, we take well-known concepts and wrap them within a cadence and pace that allows the team to make changes at a very small batch size. Think how small a change we can experiment with to see a discernible difference, and then make that change and see what results. Instead of trying to optimize a creative process, just focus on improvement. We will see quickly with our experiments whether or not we are heading in a useful direction. Then we can pivot in the next iteration without an enormous amount of time, effort or reputation on the line. As we experiment, there be will times when there is a concerted focus on one aspect of a value or principle, or there may be a realization that some of our processes are obsolete.

There are certain constraints to the utility of our three groups as we begin to generalize for all process and the creation of all products, so we need to keep this discussion within the context of creating complex products that do not have a deterministic representation of good.

In this paper, we define how to shift an organization's mindset in order to capitalize on what Scrum and Kanban have suggested with regards to organizational constructs and how to shift the terminology to yield the promise of what it means to "be agile." We explain how to effectively implement the priorities and principles that continue to guide teams doing complex projects in a new way of thinking, as outlined in the Agile Manifesto. We caution that the longer the manifesto is preached in an organization without incorporating a shifted mindset, the more likely the organization is to lose the geometric benefits of the new organizational constructs and unique approach.

If an organization is truly able to understand and implement the principles of Agile in the context in which they were intended, the benefits will be notable, including the organization's increased value delivery by self-organizing teams. By making these adjustments, organizations will be able to unlock the innate ability of the combined knowledge of each individual. How long this process will take for well-established organizations is not well defined, which makes the transition largely based on how quickly leaders at all levels can understand and embrace Agile thinking.

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CONFERENCE PAPER

IRNOP 2017 – Reflections from a Co-chair

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Well, the dust has now settled on the 2017 International Research Network on Organizing by Projects (IRNOP) Conference, hosted by Boston University (BU) in Boston, Massachusetts. My project management faculty colleagues from BU and I spent 18 months planning, organizing and executing this project, and it seems to have been something of a success. This was to be the first time that IRNOP was held in the United States, and we were keen to make it a memorable experience.

My thanks go to the other co-chairs and members of the organizing team at Boston University – Professors Vijay Kanabar and Roger Warburton. Vijay was the one who persuaded the IRNOP committee that Boston would be a great venue for the 2017 conference, and Roger saw this as his "swansong" before his retirement from full-time academia. I also need to thank our other PM colleague – Ginny Greiman – and the support and sponsorship that we had from the Metropolitan College Dean's Office. Thanks must also go to the department administration and our Marketing Department, whose members "stepped up" to advise on branding and to design the conference program, the banners and the other materials.

I previously attended IRNOP in 2013 in Oslo, and Vijay and I attended the IRNOP 2015 conference in London, where UCL set a very high bar for us to meet. They were also, however, extremely supportive, having produced a very comprehensive "Lessons Learned" document that gave us a solid starting point for our planning. They were also happy to make their budget available to us, which was incredibly helpful.

Even when you start to plan early, it is challenging to "lock down" the space and make the other arrangements that you need to make in a bureaucratic organization like BU, with 4000 full-time faculty looking for space and 33,000 students who have to take priority

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over everything else that is going on. However, we acquired the space and facilities that we wanted, and we employed a freelance project manager to make things go more smoothly with the logistics, especially the food and the social events, which took some pressure from the organizing team as the conference deadlines approached.

The IRNOP conference is an interesting phenomenon as it is almost as much a social event as an academic one. The PM research community is relatively small and tightly knit, and IRNOP is the chance for us all to meet, exchange ideas and cement old friendships. When I said, in my opening remarks, that it was a pleasure to welcome so many friends to Boston, I really meant that! I probably knew at least half of the attendees personally. So, we were determined to build plenty of networking time into the schedule, even though balancing that with the desire to include as many papers as possible was challenging.

This was the largest IRNOP conference yet, with around 170 attendees and over 130 papers submitted. We were able to accept and create space for 81 papers, giving an acceptance rate of around 61%. We also accepted 12 poster sessions, mostly from PhD researchers. The peer review process was daunting, and we did about 60% of this within the BU academic community. However, I believe that the final program contained excellent and academically challenging papers, and interesting themes and tracks covering a wide range of areas. I was personally very pleased to be able to develop tracks focusing on Innovation in PM, Contemporary Approaches, and Sustainability. To me, IRNOP is about "new ideas," and the discussion of those ideas as they – hopefully – move into mainstream PM discourse in due course. This view was reinforced in my conversations at the conference with Rolf Lundin, who was one of the initial driving forces behind IRNOP almost 25 years ago. It therefore seemed appropriate to ask him to deliver the opening keynote.

Almost every academic of substance working in the PM field attended IRNOP in Boston. This allowed us to arrange meaningful plenaries around the editors of the main journals, to explore the development of theory in PM, and to invite Harvey Maylor to close the conference with a provocative and interesting closing keynote session. Feedback from attendees was very positive, and we were also able to slot in a couple of book launches as a part of the proceedings.

Before the IRNOP Conference formally "kicked off," a very successful Doctoral Workshop took place, with 12 doctoral students presenting their work, which was constructively critiqued by a group of experienced academics, ably led by Darren Dalcher and Yvan Petit. The organizers felt that it was very important to build this activity into IRNOP in order to support those who are destined to become the future of PM research. Encouragingly, Darren suggested that some excellent and academically rigorous work was presented at this workshop.

Needless to say, we tried not to neglect the "social stuff." The opening reception and registration on the Sunday evening took place in the atrium of the Questrom Building on the BU campus. This was a meeting of old friends, and a few new ones, and although it was scheduled to end at 8.30 p.m., there was still a significant contingent socializing at 9.30 p.m.! Monday evening saw attendees being bussed to the Boston waterfront, where the dinner was on board a luxury yacht. It was a beautiful, warm evening, and most attendees spent so much time on the top deck chatting and watching the sunset that some of us were still being served dinner as the yacht docked a few hours later. Maybe this was helped by the free bar. It is important to thank the Project Management Institute (PMI) for their generous sponsorship of this event. We also fortuitously docked just as a fireworks display was starting over Boston Harbor. I was a little worried that maybe somehow this was coming out of our budget, but it was just a serendipitous and lucky aligning of fates, and a spectacular end to the evening.

Tuesday evening offered a "duck boat" tour for those that were keen to see a little of the city, and then attendees broke up into parties to eat at many of the restaurants and bars around Boston. I think it was fair to say that there were a few attendees who were "less dynamic" than usual listening to the Wednesday morning paper presentations.

Wednesday afternoon started with the aforementioned closing keynote from Harvey Maylor, followed by the conference handover, where Derek Walker, from RMIT in Melbourne, pledged to deliver the next IRNOP conference in December of 2018. The final activity was the Awards ceremony, with PMI and IPMA conferring sponsored awards on attendees for best papers and for exemplary research. I was also personally delighted to see the inaugural PMI award for Teaching Excellence go to one of my colleagues and co-conference chairs – Vijay Kanabar.

Thank you to all who attended, presented, sponsored and contributed to making this a valuable and enjoyable experience.

Steve Leybourne

Co-chair – IRNOP 2017

Metropolitan College @

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CONFERENCE PAPER

Decision-making in project portfolio management: using the Cynefin framework to understand the impact of complexity

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Synopsis

The majority of project portfolio management tools are not flexible and responsive to complex and dynamic environments. This can result in business losses when management does not effectively adjust project portfolios to meet organizational and contextual needs. This paper concentrates on the impact of individual decision-making, perceptions of decision processes and the influence of uncertainty on effective decision-making in project portfolio management.

Relevance for practice and education

This research explores the impact of real-time events on managers during decision-making processes for project portfolio management, using a purpose-built simulation. The simulation development was informed by the Cynefin framework. The Cynefin framework emphasizes

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the importance of applying different leadership styles and decision-making approaches depending upon the complexity of the situation.

Research design

A multi-method, abductive research process was used to collect and analyse the data. Data collection involved four complete iterations of a purpose-built simulation, resulting in 66 datasets of individuals' perspectives of the project portfolio management decision-making process, under varying levels of complexity. The research data were focused on participants' perceptions of their efforts to manage key decision turning points through two "real-time" events, simulating project cancellations and organizational change.

Main findings

Participants were found to use different approaches to decision-making, depending on the complexity of the situation. The findings show that participants' roles in the simulation, participants' experience, decision makers' feeling, the maturity of team cognition, and diversity of participants are key considerations that influence the success of decision-making under uncertainty in PPM contexts.

Research implications

The findings in this study build on previous research in a number of ways. They demonstrate the effectiveness of simulation as a data collection technique in project management, an approach which has hereto been rarely used. This research also develops our understanding of portfolio decision-making by directing attention from rationalist approaches to the consideration of emotion, real-time events and individuals' decision-making styles, reflecting something closer to the lived experience of project portfolio management.

Keywords

Project Portfolio Management, Decision-making, Cynefin, Simulation, Complexity

Introduction

Project portfolio management (PPM) has been developed to assist in the management of interrelated groups of projects and programs; aid in the selection of projects within a portfolio, and their alignment to organizational intent; and to facilitate communication amongst internal and external stakeholders with regard to decision-making on clusters of interrelated projects. PPM is particularly vital in contexts where complex decisions need to be made involving groups of stakeholders within, and external to, organizations. The dominant trend in decision-making during the planning and implementation of multiple projects is driven by a rationalist perspective, emphasizing financial analysis. Optimization methods apply linear and stable assumptions to create decision trajectories for portfolio roadmaps (Belaid, 2011; Ghasemzadeh, Archer, & Iyogun, 1999; Project Management Institute, 2012). However, in many cases, the environment is changing so quickly that changes are not captured effectively by the decision makers working on project portfolios. Further investigation of decision-making process in PPM contexts is needed if organizations are to account for sudden changes. Management of the process for identifying and controlling uncertainty affecting project

portfolios is a key challenge for project practitioners and researchers. However, understanding the perceptions of individual decision makers in connection with their decision-making is not yet subject to much research.

This research explores how real-time events affect decision makers in a PPM context. This paper discusses the use of a novel approach to research, data generation and analysis to create recommendations for consideration by practitioners and researchers. The research problem being explored is:

What is the impact of real-time events on managers during PPM decision-making?

This paper extends the previous work of authors (Robert Gravlin Cooper, Edgett, & Kleinschmidt, 2001); (Killen, Jugdev, Drouin, & Petit, 2012; Martinsuo, Korhonen, & Laine, 2014; Y. Petit & Hobbs, 2012) and other researchers (Kurtz & Snowden, 2003; Leigh & Kinder, 2001; Remington & Pollack, 2007) into the management of uncertainty and decision-making for project portfolios. The research reported in this paper included the development of a simulation (Hooshmand-1) for replicating scenarios involving unexpected change and complex PPM decision-making contexts. The Cynefin model of Domains of Knowledge (Kurtz & Snowden, 2003) informed the development of the simulation and provided the research framework for this study. Data generation and analysis made use of SenseMaker software to provide insight into the types of actions and strategies required when facing unanticipated change during decision-making in the context of PPM.

Literature review

Project portfolio management is a multidisciplinary response to aligning corporate strategy with the specific tasks of choosing and executing the right projects. Project portfolio management is defined as the management of projects and programs to achieve strategic goals as set out in a corporate strategic plan (PMI, 2006). The three key goals for implementing PPM across a corporation have been identified as (i) maximizing the value of the portfolio; (ii) achieving the right balance and mix of projects; and (iii) linking the portfolio to the strategy of the business through implementation of PPM (Robert G. Cooper, Edgett, & Kleinschmidt, 1997a, 1997b). Corporations with multi-project structures challenge top management teams, as these practices begin with competing resources for projects at the same time, and the maturity of organizations to establish PPM as a key functional responsibility for senior managers. Engwall and Jerbrant (2003) stated that a multi-projects corporation carries out the majority of its business operations through the execution of projects. The standard of portfolio management (Project Management Institute, 2012) concerns common sense for the implementation of PPM across organizations. This standard discusses definitions and concepts aimed at achieving a balance among key goals for profitability, strategic alignment and resource utilization.

Several models and frameworks discuss various perspectives to the alignment processes between corporate strategy and projects. Archer and Ghasemzadeh (1999) proposed an integrated framework for decision-making on projects selected for portfolios. The strategic implications of project selections are complex, as they depend on internal and external factors (Archer & Ghasemzadeh, 1999). Connecting strategic management and PPM as a relevant capability for corporates to plan and implement strategically and effectively are proven for the PPM context (Killen et al., 2012). Kodukula (2014) described the funnel model as a good guide for practice to combine tactical and strategic views for PPM planning and implementation. The funnel model uses three gates: (i) initiation, (ii) development and (iii)

production (Kodukula S., 2014). The production gate is when the delivery of project values commences. Furthermore, a strategic framework was introduced to lay out the sustainable decision criteria and fuzzy-based decision-making models for decisions on project portfolio selection and evaluation (K. Khalili-Damghani & S. Sadi-Nezhad, 2013). K. Khalili-Damghani and S. Sadi-Nezhad (2013) argued that the framework use of Balanced Score Card (Kaplan & Norton, 2001) provides feedback to evaluation and assessment processes.

Complexity in project portfolio management processes is inherent and contingent. Complexity is inherent in the process because of the multifactor and multi-stakeholder process of analytic and rational decision-making for project selection., prioritization and authorization of projects (Gemünden, Kock, Kopmann, & Schulz, 2015). The complexity of the processes is concerned with key determinants for the number of elements, the degree of interdependencies between elements, and the predictability and magnitude of changes to these elements and their interdependencies (Daft, 1992; Dietrich, 2007; Dooley & van de Ven, 1999; Levinthal & Warglien, 1999; Ribbers & Schoo, 2002; Teller, Unger, Kock, & Gemünden, 2012). Changes in the elements and interdependencies can happen because of internal and external factors (Martinsuo et al., 2014).

A wide variety of advanced, computerized, and formalized processes exist for aiding project selection, prioritization and decision-making (Archer & Ghasemzadeh, 1999; Gemünden et al., 2015). Several quantitative models and frameworks have been developed to aid with the complexity of multidimensional problems for PPM. Financial and non-financial indicators at the project level could assist the decision-making process. According to Costantino, Di Gravio and Nonino (2015), deciding on project critical success factors is an important criterion for PPM, as decision makers deal with probable causes of failures during project selection processes. These authors argued that using artificial neutral networks provides a simpler approach for top manager engagement in the decision-making, facilitating communication loops between project managers and project portfolio managers to assess the riskiness of project success based on the project managers' past experience (Costantino et al., 2015). Maged (2008) describes a multiple criteria decision-making (MCDM) model to find the optimized solutions for R&D projects where resources dependencies pose constraints on the decision-making process for project selection. MCDM is also used to measure the performance of project portfolios to make decisions on strategic changes to and use a variety of criteria, which are required for the decision maker to reprioritize the projects based on their performance (Rogério Tadeu de Oliveira, Ensslin, & Sandra Rolim, 2011).

Arguably, companies are struggling with sub-optimization and irrational decision-making processes (Martinsuo, 2013). Müller, Martinsuo and Blomquist (2008) challenged the contribution of several tools and quantitative methods for project portfolio optimization to the performance of project portfolio management. Kaiser, El Arbi and Ahlemann (2015)) emphasized that despite developments in project selection models for decision-making, the key to successful implementation of PPM is the organization structure and its alignment with decision-making criteria.

Some have argued that project portfolio management methods are not mature enough to support organizations during uncertain conditions because of its focus on rational decision-making (Arlt, 2010; Martinsuo et al., 2014). In parallel with methods and processes, competencies the top management team who use the methods for decision-making is at a great attention. Martinsuo stated that skills and competencies for managing project portfolios should extend to the project management teams. Furthermore, senior managers need to

support the development of dynamic capabilities across organizations to overcome uncertain and changing environments (Yvan Petit, 2012).

Uncertainties are beyond the analysts' ability to predict events and cannot be reduced to the risk level (Quade, 1989). The quick-changing environment is a reality of the business environment. The changes influence decision makers' perceptions for choosing processes and decision criteria. Christiansen and Varnes (2008) suggested that decision makers have to deal with multiple criteria and, sometimes, conflicting interests. Thus, decision makers move away from traditional rational thinking and try to adopt a sub-optimal problem-solving approach. Martinsuo et al. (2014) asserted that external uncertainty could be related to factors such as competitors' actions, customers' needs or changes to macroeconomic conditions.

Korhonen, Laine, and Martinsuo (2013) asserted that managers cannot stick to their rational decision-making approach when facing uncertain or unknown conditions. Furthermore, there is a need for further research into how to manage uncertainty in PPM (Korhonen et al., 2013; Yvan Petit, 2012). The extended framework for managing uncertainty offers categorization of uncertainty based on the sources of uncertainty – external context, organizational context and single project changes – in which managers can identify and prepare a contingency plan to overcome those events (Martinsuo et al., 2014).

Facilitation of decision-making in a project portfolio committee through a crafted framework might provide top managers with a mechanism to manage unexpected events during decision-making for project portfolio decision processes. Yahaya and Abu-Bakar (2007) argued that group decision-making is across all decision-making processes and is used as a powerful mechanism to overcome factors of uncertainties during a decision-making event for project portfolios of new product development. Group decision-making is known as a tactic for strategic planning, where decision makers have to overcome uncertainties. Strategic decision-making and project selection and termination processes can benefit from group decision-making to mitigate risks or uncertainties (Kaveh Khalili-Damghani & Soheil Sadi-Nezhad, 2013; Shepherd & Rudd, 2014).

Decision-making in a PPM context is a complex process. The research discussed above demonstrates the need to account for individual contributions to decision-making, group decision-making and a changing and uncertain context. Although many tools and applications exist to assist in this process, the literature suggests that the ability of these approaches to deal with complex environments has been constrained by an underlying rationalist perspective.

FRAMEWORK FOR ANALYSIS

Complexity and uncertainty are being recognized as creating fundamental difficulties for decision makers, especially when senior managers have to make decisions without sufficient information (Gorzen-Mitka & Okreglicka, 2014). Remington and Pollack (2008)) categorized four types of project complexity: structural, technical, directional and temporal. For example, the physical size of projects or the extent of technical interdependencies can result in complexity for decision-making (Remington & Pollack, 2008).

Seeking to make sense of complexity leads to a more proactive identification of sources of uncertainty and for early signs of failure (Kappelman, McKeeman, & Zhang, 2006). Weick (1995) argued that people apply sense-making as a tool to overcome ambiguity and associated interpretation to that condition. Shrivastava (1987) stated that individuals engage in sense-making to find out what to do next, as well as a way of dealing with the anxiety and fear in complex conditions that may accompany the disastrous experiences. Hence, a framework

of making sense of complex situations can be a mechanism to manage uncertainty for top management decision-making.

Cynefin, a Welsh word that means "habitat" (Kurtz & Snowden, 2003), is used for knowledge exchange and as a framework that helps decision makers making sense of complexity through relaxing boundaries and assumptions deriving from existing theory, belief or practices (Krems, 1995; Sardon & Wong, 2010). According to Kurtz and Snowden (2003), there are five domains for the Cynefin framework: simple, complicated, complex, chaos and unordered.

The Cynefin framework has been used in collective sense-making to enable emerging understanding through the discourses of group decision-making (Tomasini, 2013). According to Kurtz and Snowden (2003), the Cynefin model provides ways to open up discussions, identify barriers, stimulate attractors, encourage dissent and diversity, manage starting conditions and monitor for emergence in order to manage complexity and stabilize uncertain conditions. Application of the Cynefin framework to boost project managers with their decision-making capabilities is evident with the Legos (Tomasini, 2013).

The application of the Cynefin framework for creating simulation scenarios in complex and complicated domains and a reflection framework for participants in the simulation is discussed in the next sections.

Research methodology

This research involved two main research methods: the design of an original simulation (Hooshmand-1) for generation and collection of data and the use of the SenseMaker software to collect and analyse data. Each is discussed here in turn.

SIMULATION

Simulation is 'the abstraction of reality for a purpose" (Leigh 2013, p. 200). It has been in use for thousands of years for many different purposes and in various modes such as war games and board games (A.J. Faria, Hutchinson, Wellington, & Gold, 2009).

Simulation has diverse uses for research and practice, and is an attractive tool for training and education where "what-if" questions can be explored through the use of different scenarios, helping learners by providing experience-based activities (Aldrich, 2005; Banks, Carson, & Nelson, 1996). Training for performance improvement in risk-oriented contexts, such as those experienced by emergency medical crews, firefighters, and in surgery and nursing, is often conducted via simulation, which provides relatively safe environments for learning while avoiding adverse real-life consequences (Okuda, 2009; Rosen, 2008; Sa. Silva, Pedrosa, Trigo, & Varajao, 2011).

Simulation, as a research and exploration tool, is found in technical disciplines including crisis management (Walker, GIddings, & Armstrong, 2011) and operations management (Zee & Slomp, 2009). Simulation is also recognized in the human sciences as a means of building formally arranged structures that become temporary knowledge transmission spaces, allowing researchers to explore specific aspects of human behaviour (Sá Silva et al. 2011). The context in which specific simulations are applied greatly influences their design, for example entrepreneurship education using simulation as a method for teaching complex business interrelationships applying concepts unique to that context (Huebscher & Lendner, 2010).

Use of simulations in project management is growing. While computational simulations are being used for "discrete event simulation" where the complex systems can be simplified to sequence of pre-defined events (Hengst, Vreede, & Maghnouji, 2007), role-play simulations are being used for strategic decision-making and also the study of decision-making on project portfolios as well as other educational purposes (Culpin & Scott, 2012; A. J. Faria & Wellington, 2004; Hussein, 2007; Keys & Wolfe, 1990; Leigh & Kinder, 2001). Simulations are also used to improve understanding of the nature of complexity (Killen, 2013; Leigh, 2013).

Role-play-based simulation has many applications for the education of both adults and children and has a long history of use (Leigh & Kinder, 2001). Role-play is "a technique (used in games and simulations) in which participants act out the parts of other persons or categories of persons" (Leigh & Kinder, 2001, p. 10). Role-play simulation is used for close-to-reality settings that engage participants in experientially based events to help them enhance their skill and capabilities (Clapper, 2010).

The design of a simulation is intimately connected to the features of the context being represented and is shaped by the nature of the intended research or learning objectives. Stainton, Johnson, and Borodzicz (2010) identify three principles that contribute to a viable simulation design as being representation, content and implementation. Each of these is elaborated on here.

To be effective, e a simulation must provide a realistic representation of the real environment (Duffy & Cunningham, 1996; Elgood, 1993). Shalbafan, Leigh, Pollack, and Sankaran (2015) argued that a viable model for simulation must replicate known conditions. To be effective, a simulated representation must address complex and challenging situations without unnecessarily confusing participants (Leigh, 2013).

Content is the second important principle in each simulation design. This includes the rules, materials, venue, processes and support tools, all of which must be true to the context of the simulation (de Caluwé, Geurts, & Kleinlugtenbelt, 2012). Well-developed content needs to be challenging for participants and present a framework for generating knowledge (Shalbafan et al., 2015).

Implementation refers to the facilitation processes that guide and manage the performance of the simulation. Timing is a key factor. A simulation must include time for sufficient analysis afterwards as well as allowing time for players' decision-making, reflection and discussion within the activity (Hall, 2004). The facilitator needs to be a knowledgeable person in order to provide technical assistance to participants (Hall, 2004; Wolfe, 1997).

The use of simulation has grown to include training, education, decision-making and crisis management for many groups including middle and senior managers (A.J. Faria et al., 2009). The use of simulation for project management has helped students in postgraduate courses to understand the complexity that can occur during construction projects. For instance, BoBs Building is simulation software that covers subjects such as planning and controls, network analysis, risk management, earned value for training and education (Hussein, 2007). Other business simulations support learning about organizational changes and decision-making on strategic matters (A.J. Faria et al., 2009; Joldersma & Geurts, 1998).

Simulations are also increasingly being used for research projects, demonstrating advantages such as allowing for participants' subject expertise, motivation and opportunity for group discussions (Elgood, 1997). Simulations can also address communications, critical thinking and emotions as research factors, as well as providing participants with learning

opportunities (Clapper, 2010). Finally, simulations offer researchers opportunities to compare qualitative and quantitative data at the same time (de Caluwé et al., 2012). Simulations enable researchers to study decisions and activities that are extraordinary, dangerous, risky and obscure organizational environments (de Caluwé et al., 2012).

Simulation Hooshmand-1 was created to expose participants to two predefined scenarios. In each scenario, participants adopted a role and contributed to group decision-making about items on a list of project portfolios. In the second scenario, two real-time events were introduced to assess participants' capability for coherent decision-making after receiving news of unanticipated but predictable events.

The simulation process follows these steps:

1. Briefing
2. First scenario
3. Reflection on the first scenario
4. Second scenario
5. Reflection on the second scenario
6. Debriefing

The two scenarios were developed using data from a case study of IT companies in Canada (Yvan Petit, 2012). Both scenarios are set in the Sydney headquarters of a fictional international IT company. The context is a meeting of the project portfolio committee chaired by the director of product development unit (PDU) based in Sydney and attended by heads of the application development (AD), and integration and verification (IV) divisions. The scenarios are dynamic and competitive, including sources of instability related to product content, unstable standards and unclear customer requirements about products.

Narratives are a commonly used sense-making tool for interpreting how people make sense of uncertain conditions or complex problems. Rituals, belief and experience are all ways that people make sense of events, and thus they respond to organizational shocks, such as mergers, layoffs and expansions, using very different perspectives (Mills, Thurlow, & Mills, 2010). Narratives (Weick 1995; Weick 2005) are active lenses to monitor individual behaviour, as participants' stories discuss who said what to whom with what effect (Mills et al., 2010; Weick, 1995, 2005).

Narrative research can assist the research subjects to make sense of a complex situation, and that contributes to data analyses with less researcher bias as a reliable research method (Browning & Boudès, 2005). Storytelling (Callahan, Rixon, & Schenk, 2006), games and simulations (Leigh & Kinder, 2001) are known tools to make sense of complexity. Stories are richer research instruments than conventional questionnaires and interviews because they bring the subjects' opinion directly into the research field (Berry, 2001; Boudes & Laroche, 2009; A.D. Brown, 2004; A.D. Brown & Jones, 2000). SenseMaker software was introduced to narrative research, which enables visual presentation and analysis (GORZEŃ-MITKA & OKRĘGLICKA, 2014) of stories collected in narrative research.

SenseMaker software, associated with the Cynefin framework, can be used to support decision-making and metadata analysis when used with large numbers of participants. This software is becoming widely used for making sense of complex problems (Gorzen-Mitka & Okreglicka, 2014; Snowden & Boone, 2007). Sardon and Wong (2010, p. 5&6) have described the key benefits of using SenseMaker as follows:

- Allows distribution of the analysis load across participants and makes it possible to analyse the stories in a relatively short time

- Reduces the authors' bias that might be introduced in the interpretation of the stories. In doing so, each story contributor makes sense of one's story
- Engages the participants and positively prepares them for the next steps. Involvement is a key success factor for the long-term success of any intervention.

Sixteen attributes were selected as indicators of features relevant to understanding the research questions (Table 1). A questionnaire using the SenseMaker software was developed to collect data from participants as they made sense of their experience in each scenario.

Table 1 Attributes of simulation and codes in the sense-making framework

No.	Attribute Description	Code	Scenario
1	Participants' feeling	Q9	SC1
2	Criteria of decision-making	T1	SC1
3	Drivers for individual decision-making	T2	SC1
4	Sources of uncertainty	T3	SC1
5	Perception of final group decision	T4	SC1
6	Group adaptation to decision-making Process	T5	SC1
7	The focus of task on team vs. individual	Q11	SC1
8	Participants' feeling	Q14	SC2
9	Perception of impact on decision makers for the first real-time event	Q16	SC2
10	Perception of impact on decision makers for the second real-time event	Q17	SC2
11	Drivers for individual decision-making	T6	SC2
12	Shift of criteria for decision-making because of real-time events	T7, T8 &T9	SC2
13	Group adaptation to decision-making Process	T10	SC2
14	Individual perception for factors to overcome changes on decision-making process	T11	SC2
15	Sources of uncertainty	T12	SC2
16	Perception of final group decision	T13	SC2

SenseMaker provided measuring mechanisms, including distribution diagrams, to support the analysis of qualitative data, and it proved to be an efficient tool for data collection and data analysis for this research. SenseMaker allows the provision of a variety of data collection techniques, including dyads, triads, micro narratives and multiple-choice questions. A dyad is a two-dimensional signifier that assesses the subjects' perception in a range between 0 and 100. A triad is a three-dimensional signifier and assessment tool. Respondents are asked to balance the relative significance of three signifiers by placing a point within the area of a triangle. Micro narratives are respondents' short stories, images, videos or audios that they use to make sense of a complex situation.

To collect the data, participants responded to questions by writing a micro narrative or a short story to describe their experience at the end of each simulation scenario. Participants

were asked to describe key turning points during each. They were also asked to describe aspects of the simulation experience by positioning response points on a selection of triads, indicating their perception of the significance of a variety of factors.

Four simulations were conducted using the SenseMaker software to collect data from participants. After each simulation scenario, participants underwent a reflection through listing turning points from the end to the beginning of the scenario, and they wrote a short fragment or micro narrative on their experience for each turning point, followed by signifying their stories in a questionnaire. There were 33 participants, generating 66 data sets from two scenarios in each experiment. A standardized process of facilitation – simulation protocol – was used to minimize variations of facilitator's performance between simulation sessions with different groups of participants.

The participant selection process was tailored depending on the type of volunteers and the context of each simulation. Participants were recruited from professional and postgraduate research students.

Data analysis

Micro narrative analysis and the Cynefin framework were used to assess participants' perceptions about key turning points. The micro narrative stories were considered in relation to three parameters (i) Cynefin domains of knowledge used for decision-making, (ii) experience of real-time events and (iii) turning points within those events. These fragments were assessed and led to the identification of three distinct clusters of participants (see Table 2).

Cluster 1 – These six participants were people who identified real-time events and noted the influence they have on decision-making processes in their micro narratives

"Before the cancellation of program 4, we had a list of potential projects that we wanted to choose for this exercise." This was taken to indicate the simple domain of known information on the Cynefin framework. "After briefing the CEO and explaining the situation to them, we came to a disagreement." This was taken to indicate the disordered domain on the Cynefin framework.

Cluster 2 – These 12 participants were people who identified turning points other than real-time events and named their impacts on the decision-making process.

"Initially it *was not clear* for me that the first thing we needed to do was to calculate the total number." This was assessed as indicating the chaos domain. Or, "We could go easier with the second-year project." This references the complicated domain.

Cluster 3 – These three participants were people who identified turning points other than real-time events, but did not indicate that these have any impact on the decision process.

"Interpreting the data and the interdependencies on the spreadsheet was most difficult." Or we have focused the scheduling of programs with high NPV, ENPV and resource fit." These were understood to indicate the complicated domain on the Cynefin framework.

Shifts and movements between Cynefin domains are considered significant as they affect the decision-making process. Participants whose responses contribute to the first cluster were able to recognize that events occurring during the simulation had impacts on the decision-making. This was concluded after analysing all responses to the first prompt question for listing turning points. Participants, depending on their background, had shown very different approaches to identify real-time events in the simulation as a key change factor for decision-making that

Table 2 Participants in three clusters

Code: Either Number or Pseudonym	Group Colour	Role	Workshop Number	Cluster
1	White	AD	1	1
2	Green	IV	2	
3	Green	AD	3	
4	White	AD	3	
5	Green	IV	4	
6	Green	PDU	4	
7	White	PDU	1	2
8	Red	IV	1	
9	White	IV	1	
10	Green	IV	2	
11	White	AD	2	
12	Red	PDU	2	
13	Green	IV	3	
14	White	IV	3	
15	Red	AD	4	
16	Green	IV	4	
17	Green	AD	4	
18	Gold	PDU	4	
19	Green	PDU	1	3
20	Red	PDU	3	
21	Green	PDU	4	

their groups made. Those six participants whose responses are included in this cluster described a different sequence of changes in decision-making as a result of real-time events. Although these participants were not aware of the domains in the Cynefin framework, their micro narratives describe the awareness of immediate events and the influence on their own decision-making. The change in how each participant perceived how his or her group made decisions is discussed following, with reference to the Cynefin model. Analyses of each participant in the cluster area are presented as coded in table 2.

SHIFT FROM SIMPLE DOMAIN TO CHAOS

Participant 1 recorded two real-time events in the second scenario of Hooshmand -1. The known situation outlines the Simple domain in the beginning. The cancellation of a project triggers a shift to the Complex domain, where discussions among teammates help raise awareness on the changing situation. The increased understanding moves the team to the complicated domain, where prioritizing techniques help decide outcomes. The second real-time event involved a change of leadership. This shifted team members to the Unordered domain, and agreement was not reached. The team concluded in an endless discussion in the Chaos domain. Figure 1 illustrates this movement.

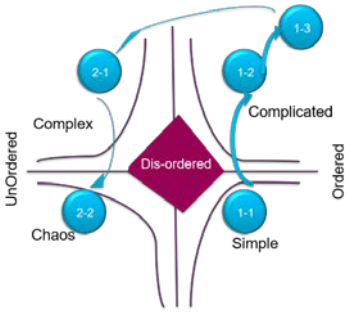

Figure 1 Transition of domains from Familiar to Chaos

SHIFT FROM COMPLICATED DOMAIN TO COMPLEX

Participant 2 identified real-time events in the sequence shown in Figure 2. The first real-time event forced the team to re-evaluate their work because of the emerging situation. The decision-making domain then shifted to Complicated when an analytic approach was adopted. Figure 2 demonstrates the movements in different domains.

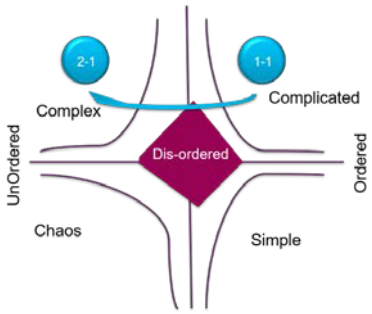

Figure 2 Transition domains from Complicated to Complex

MOVEMENTS BETWEEN COMPLICATED AND COMPLEX DOMAINS

Participant 3 recorded two real-time events. Their group commenced work in the complicated domain, where the expectation from headquarters is known to teammates, and they need to use their analytic expertise to find the solution. The change of team leader shifted the domain to Complex because of the consideration that the new member may have different expectations that could emerge as a new strategy. However, the group shifted back to the Complicated domain through discussion and knowledge sharing. At the cancellation of a project during the second turning point in scenario 2, the group kept their decision-making consistently in the Complicated domain (Figure 3).

FROM CHAOS TO DISORDERED

Participant 4 identified that there were two real-time events and used the future backwards approach (Gorzen-Mitka & Okreglicka, 2014) to list turning points and micro narratives. In the beginning, self-confidence helped this participant to use known facts in the next context; hence, it resembles a simple domain. Upon cancellation of a project as a real-time event, the group wasted times on recalculations, indicating working in the Chaos domain. When the

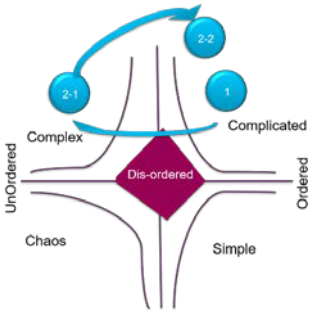

Figure 3 Transition domains between Complicated and Complex

new team leader arrived, team decision-making shifted into Disorder as conflict arose with different perspectives to the solutions, and there was no real agreement about how to proceed; this is what Unordered would mean (Figure 4).

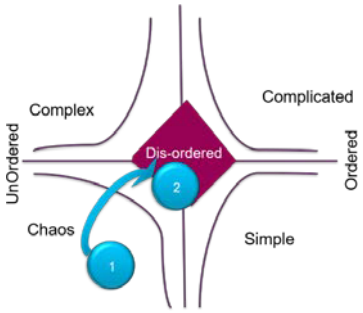

Figure 4 Transition domains from chaos to disorder

SHIFT FROM DISORDERED TO COMPLICATED DOMAINS

Participant 5 recorded two real-time events, but the micro narratives described the impact of only one of the two on the decision process. The cancellation of the project shifted them from Confusion and Conflict on a sideline matter (how to define probability) to a more relevant matter in the simulation. This moved the decision-making from Disorder to the Complicated domain when they started working on known information with analytical tools. Figure 5 illustrates this.

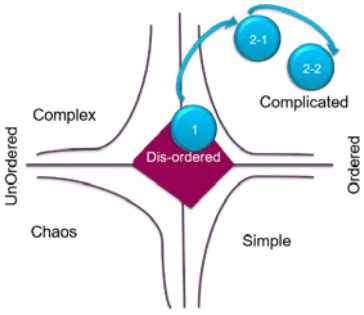

Figure 5 Shift domains from disorder to complicated

MOVEMENTS BETWEEN COMPLICATED AND COMPLEX DOMAINS

Participant 6 reported two real-time events. The future backwards approach was used to write the micro narratives. In this case, the cancellation of a project was treated positively, resulting in no change to the complicated domain to use analysis and expertise to find the best solutions. However, the second real-time event moved the new group into the Complex domain, as one of the participants could not cope with the change properly (Figure 6).

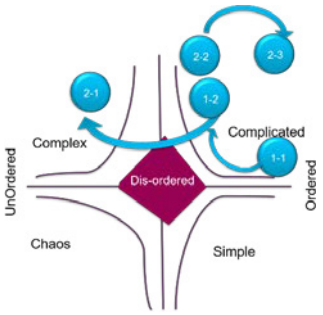

Figure 6 Shift domains between Complicated and Complex

Findings

Key findings in relation to real-time events of the data analysis are listed here:

1. Emotion of decision makers during the simulation Hooshmand-1 scenarios and the real-time event of project cancellation by a client were identified as two impact factors on individual judgement. These impact factors influenced individual perceptions for identifying sources of uncertainty during simulation and decision-making.
2. Organizational changes and decisions by a client to cancel a project were two impact factors on individual judgement for identifying key drivers for final group decision of project portfolios. The factors are influenced by real-time events as per participants' perceptions.
3. Decision-making processes are influenced by real-time events and turning points and decision style of participants
4. Participants adapted to the change to adjust decision-making processes after turning points or real-time events.

This research has resulted in a broad range of findings that can make crafting propositions quite difficult. However, at this stage the results support these two specific propositions.

Proposition 1: A successful model for decision-making of project portfolios in uncertain situations shall consider teamwork, decision makers' feelings and emotions, and the organizational roles as the three key success factors.

Proposition 2: Diversity of decision makers should be encouraged for significant decisions across organizations. This diversity will help counter the unconscious bias of decision makers when selecting criteria and assessing the final quality of decisions.

Three factors were found to affect decision-making:

- The complexity of dealing with unpredicted changes
- Organizational capacity to handle changes
- Individual decision makers' ability to manage decisions in uncertainty

Rational and information-based decision-making strategies that are usual for major projects and strategic initiatives do not effectively deal with significant and unexpected change. This indicates a lack of knowledge about risk management in project portfolio management. Furthermore, poor establishment of information systems and communication in organizations can threaten the success of decision-making for project portfolios if sudden changes are ignored during the process of decision-making. Future research should focus on the "soft factors" techniques and tools which enable decision makers to resolve issues that have their roots in more than one Cynefin domain of knowledge.

Conclusion

As decision makers for project portfolios get exposed to unexpected change events in their decision-making, the importance of research identifying sources of uncertainty and mechanisms to manage them becomes significant. Increased global uncertainty has raised the vulnerability of business leaders to deal with unanticipated change. Project portfolio management has already been a competitive advantage for both service and industries as it facilitates communication of internal and external stakeholders for decision-making on portfolios of projects in a planning time frame. However, previous research into portfolio decision-making has not focused on how decision makers address unexpected change.

This research extends previous researchers' works on increasing the readiness of industry to deal with uncertainty. Mechanisms such as engagement with decision makers' emotions, team works and diversifications were identified as procedures that help practitioners with some guidelines on how to tackle real-time events during decision-making.

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CONFERENCE PAPER

A Cross-Section of Papers from IRNOP 2017 – Boston

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The International Research Network on Organizing by Projects (IRNOP) 2017 was held in Boston, Massachusetts, in June of 2017. As a part of that conference, presenters were offered the opportunity to have their peer-reviewed conference papers published in the *Project Management Research & Practice* journal. This section is publishing those papers, which offer interesting and contemporary perspectives on a number of challenging areas in project management.

PMRP prides itself on considering projects and project-based management from a sustainable viewpoint, and the first paper, by Sabini, Muzio and Alderman, discusses the challenges of integrating sustainability into PM practices from an institutional perspective, using qualitative data to assess how professional associations are engaging with the sustainability imperative. The paper uses a framework of 'pillars' – regulative, normative, and cultural-cognitive – to consider how the management of projects is being influenced by a sustainable ethos and how PM educators and communities of practice are acting as 'regulatory agents' for change.

Another issue that has been emerging in the PM literature for some time now is that of complexity and how emerging issues add layers of complexity to what were originally perceived as projects that were more straightforward. The second paper published here, by Bowman and Crawford, considers the shift from a more conventional control theory perspective towards sense-making and reframing through storytelling to assist in resolving issues that emerge as a result of the dynamic and emergent nature of projects.

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This paper suggests that the rational, linear model of PM is essentially unworkable for most projects, and it uses qualitative data to build an argument for a more nuanced, emergent view of PM where learning from storytelling can benefit the modern, complex project. The authors offer the Storytelling Diamond model as a way to assist in effective delivery.

The third paper, by Shalbafan, Leigh, Pollack and Sankaran, also looks at the issue of complexity in the project domain and considers the impact of real-time events on managers during decision-making processes for project portfolio management in areas of significant complexity, using a purpose-built simulation informed by the Cynefin framework.

The paper suggests that project portfolios get exposed to unexpected change events in their decision-making, and that project portfolio management has already been a competitive advantage for both service and manufacturing industries as it facilitates communication with internal and external stakeholders to assist with effective decision-making in complex scenarios. Mechanisms such as engagements with decision makers' emotions, teamwork practices and diversifications are identified as procedures that help practitioners to tackle real-time events during decision-making.

Complexity in the project domain leads to innovation, and the next paper in this collection, by Brasil, Gomes, Salerno and de Paula, considers innovation at the strategic level, at the innovation portfolio level, and at the project level, and at how integration between these three levels can assist the organization. The authors lead from the premise that this environment is characterized by sequential, irreversible investments being made under conditions of uncertainty, which certainly sounds like the project domain to me. The paper uses the Real Options approach to consider four cases of organizations in Brazil, and offers some useful theoretical and practical findings.

Another paper that embraces thinking differently is the paper by Forte and Kloppenborg, which advocates the benefits of an "agile mindset" in managing projects. This paper is fundamentally focused towards the practitioner and takes the view that adopting some of the iterative concepts of agile PM can assist with the delivery of more traditional projects. It is proposed in this paper that within any project three fundamental elements are important: satisfying the customer, engaging the team and simplifying things as much as possible.

In order to offer something to help with practitioner application, the Agile Manifesto is refocused to be applicable to a broader project field, and mapped onto the customer, team and simplification imperatives within the project. The authors propose that the outcomes of this exercise, validated by a modest survey, will assist practitioners.

Following on from the logic of improving project delivery, the sixth paper in this section, by Oshikoji, addresses how to aggregate this increased performance into organization and industry-level insight. The paper argues that performance measurement should be about quantifying both the efficiency and the effectiveness of actions, and considers how the 10–10 system reports this within the Norwegian construction sector.

This collection continues with a paper that considers estimating and how accurate estimations are at the point of project completion. This paper, by Nannini, Warburton and de Marco, uses the Gompertz function within an earned value framework to predict both project duration and the accuracy of cost estimates at the completion of the project. The paper contributes significantly to demonstrating that this quantitative approach is stable, accurate and reliable, and offers practical guidance for the practitioner.

The second paper with this theme, by Narbaev and de Marco, proposes a theoretical model that looks at cost contingency in order to assist in forecasting risk-adjusted cost estimates at

the completion of the project. The paper is a contribution to bridging the gap between earned value management and cost contingency management, and as such, it provides the project manager with a model to consider how differing risk attitudes impact upon cost estimates at the completion of the project.

The final paper in this limited collection from IRNOP 2017 looks across three linked areas that are all topical at this moment. Supply chain, megaprojects, and project success factors are all of great interest to both the academic and the practitioner project community, and Radujković and Mišić explore elements of supply chain management within the megaproject domain and identify the ones that have significant influence on project performance. Interestingly, the authors make the point that megaprojects are important for the development of emerging economies, bringing us back to one of the imperatives driving the development of the *Project Management Research & Practice* journal.

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